Renewable Energy

Akshay Urja

Volume 2 ▪ Issue 5
April 2009

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अक्षय ऊर्जा से देश विकास
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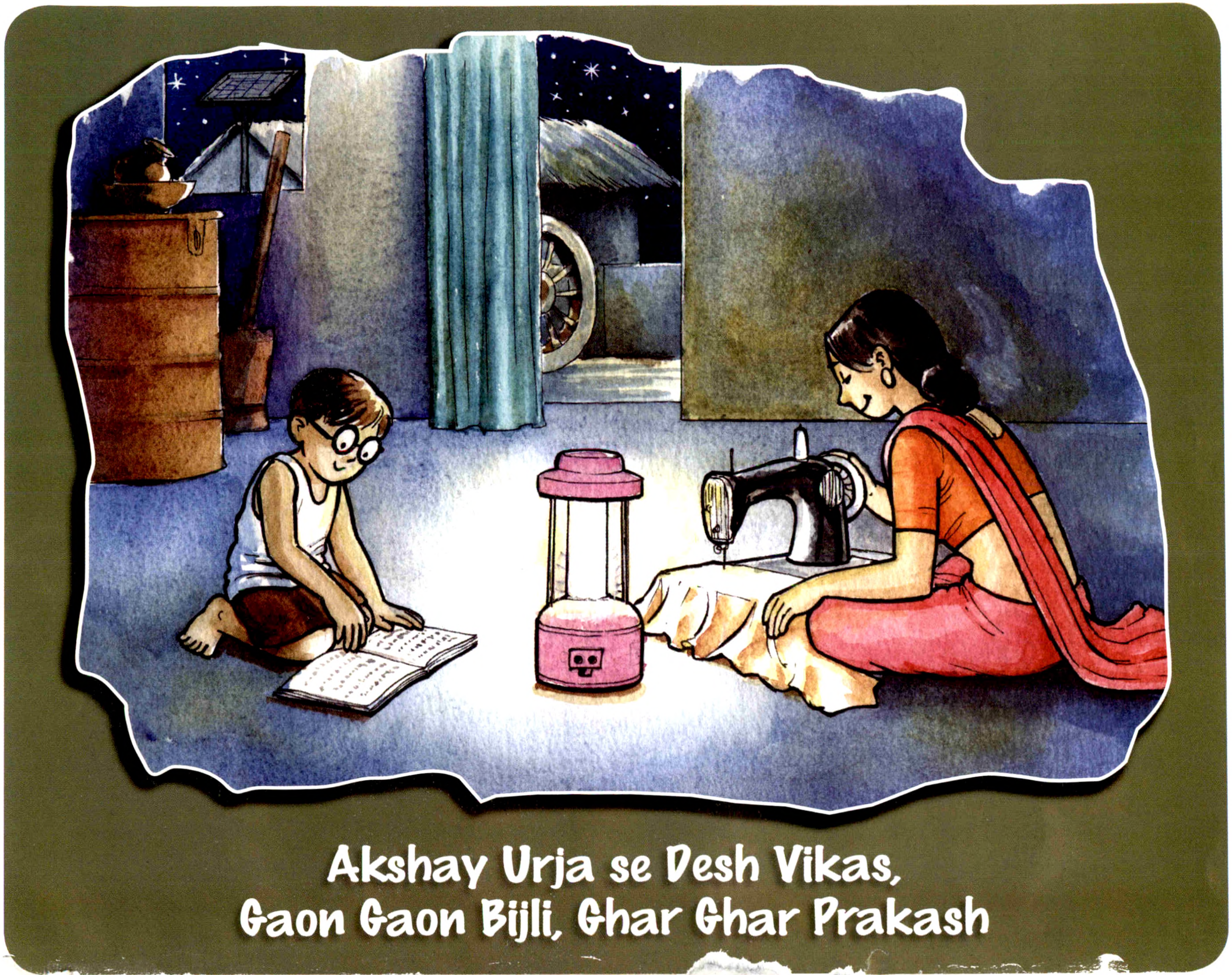
Akshay Urja se Desh Vikas,
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Renewable Energy
Akshay Urja

Volume 2 • Issue 5 ■ April 2009

A bi-monthly newsletter of the Ministry of New and Renewable Energy, Government of India

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FROM THE EDITOR'S DESK

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Dear Reader,

You will be happy to note that now the Indian Railways is committed to using renewable energy in a big way. Following the recent investments in the wind power sector, the railways are now looking at harnessing solar energy and also planning to introduce improved technologies to reduce emissions from locomotives. Solar power is being used for electrification of manned level crossings, administrative buildings, training institutes, canteens, and hospitals belonging to the railways. The railway ministry states that 128 level crossings and four stations on the West Central Railway have been provided with solar panels for electrification. Besides this, solar water heaters are also being used on a large scale. It is a very welcome development.

In fact, it is the need of today that many such giant flagship establishments/ sectors like the Indian Army, police departments, traffic department, the real estate sector, power sector, agriculture sector, shopping malls, and markets adopt renewable energy in a big way in order to resolve the energy crisis. Today, many renewable energy systems and devices, that is, solar water heating systems, solar cookers, solar home lighting, solar generators, solar lanterns, solar air heaters, solar traffic lights, solar road studs, and solar blinkers are the most common devices and systems commercially available in the market. The time has also come to adopt solar passive techniques in building designs for the new upcoming buildings to make them energy efficient.

As you know, the entire world is facing the challenge of global warming and by adopting renewable energy, we can contribute towards mitigating its effects to some extent. When you construct your new house, be sure that it is energy efficient, is designed with solar passive architecture techniques, uses solar electricity for at least lighting purpose and solar water heaters instead of electric geyser, has a rainwater harvesting system, and so on. Also, don't forget to use solar cooker as it will not only save LPG but also provide delicious and healthy food for your family. And believe me, all this is extremely affordable as well.

The present issue of *Akshay Urja* has been prepared to keep you abreast with the latest developments in renewable energy field in our country. I am sure that you will find the material informative and useful as well. We sincerely acknowledge the contribution of our writers and are encouraged with the overwhelming response and valuable suggestions from our readers.

Happy reading!

①

ARUN K TRIPATHI
<aktripathi@nic.in>

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LETTERS TO THE EDITOR

I strongly feel that Akshay Urja is a very informative newsletter and it has the capacity to become a very effective medium for disseminating information regarding new and renewable energy. I take this opportunity to congratulate you for this great endeavour and request you to regularly update me about anything in the field of renewable energy. I further want to add that it will be our pleasure to contribute to the success of this newsletter and shall send articles and success stories and other achievements of our organization to share with everyone through Akshay Urja.

Balour Singh
Director, Punjab Energy Development Agency

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I have been following Akshay Urja newsletter with much interest and would like to commend your team and the MNRE on such an initiative. Your organization, considering its strategic position, will be the primary and best source of information on the latest trends, projects, and national agendas to take India on the path of renewable energy.

Kaavya Nag
Affiliation

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You are indeed doing a marvelous job with Akshay Urja. In fact, I am really at a loss for words and congratulate you and your team involved in bringing out such a newsletter that is highly informative newsletter.

Syed M M Bukhari
Shahpura, Bhopal

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I have gone through your newsletter Akshay Urja and find that it is a highly informative and useful magazine. The articles are focused on cutting-edge technology covering relevant issues with relation to all renewable energy sources.

Dr Manju Tembhre
Principal, Sant Hirdaram Girls College, Bhopal

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Akshay Urja is a nice publication full of knowledge and practical aspects of renewable energy. Some of the articles particularly those on solar energy and bio-diesel are very important for the rural sector.

Ramesh Ch. Sahoo
Senior Electrical Engineer, Bhubhaneshwar

- - - - - - - - - - - - - -

I am indeed pleased to read your extremely valuable and informative magazine Akshay Urja. I would also like to know how to contribute towards enhancing this newsletter further. I wish the team and the newsletter all the best for the future.

Mr S Mehta
Greater Noida

- - - - - - - - - - - - - -

The newsletter Akshay Urja makes for an interesting read on all the important topics related to renewable energy. The colour combinations, photos, and the layout of the newsletter as a whole are also extremely good. All the very best.

Prof. T M Jethani
Andheri, Mumbai

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Akshay Urja is really a one-stop-shop for any information related to renewable energy. Keep up the good work.

Sanjeev Verma
IAS, Dy Commsioner, Reasi, Jammu and Kashmir

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HVAPS-India is a Solan-based NGO serving the people for the last six years. I got an opportunity to go through the July–August 2008 issue of Akshay Urja. The material was very informative and the quality of the newsletter is also excellent.

Pawan Sharma
Secretary, Himalayan Vikas Avam Paryavaran Samiti, Dist. Solan, Himachal Pradesh

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The Tamil Nadu Science and Technology Centre is an educational institution organizing seminars, workshops, exhibitions, quiz competitions, lectures, and so on. Training programmes for students, teachers, and the general public are also organized. I was very happy to go through Akshay Urja. The newsletter is very useful for our institution for conducting various programmes.

Dr P Iyamperumal
Executive Director, Tamil Nadu Science and Technology Centre, Chennai

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We are a leading multinational organization. We found your magazine *Akshay Urja* very useful and informative in updating us on the latest trends in energy conservation and applications of renewable energy sources. We wish all the best to the team in its efforts.

Ashish Chauhan
Assistant Manager – Energies, Aventis Pharma Ltd, Ankleshwar, Gujarat

Thank you very much for your encouragement. The editorial team of *Akshay Urja* will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvement in terms of content and presentation.

Editor
Akshay Urja

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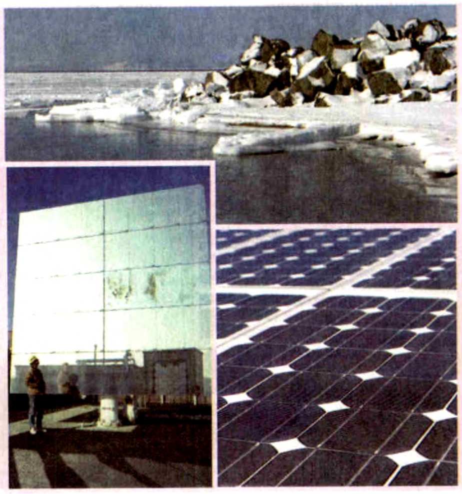

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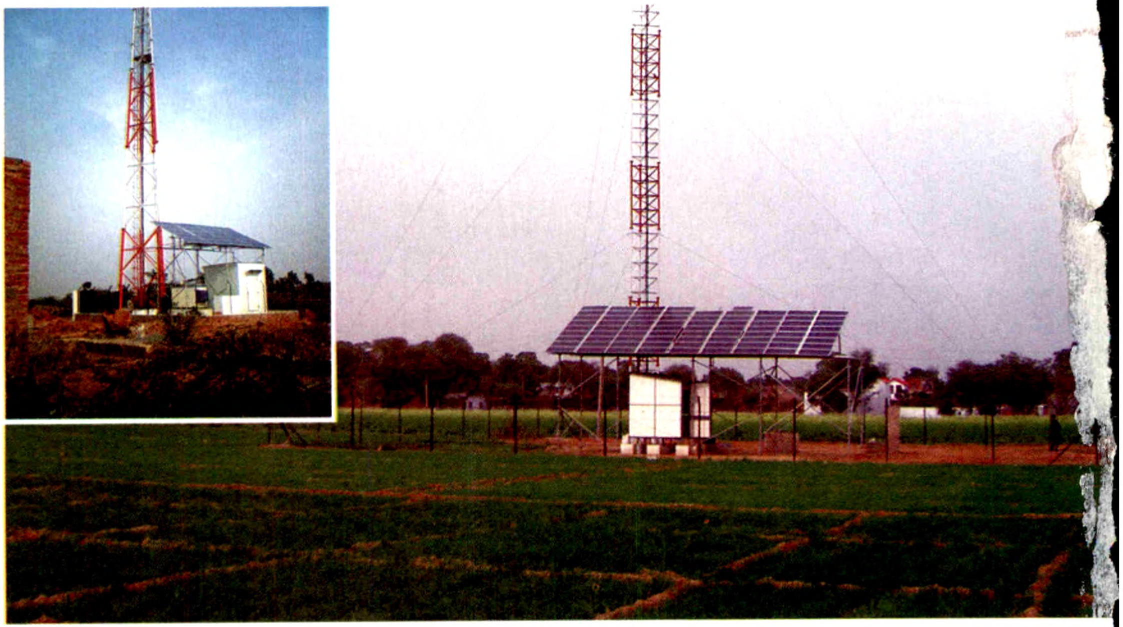
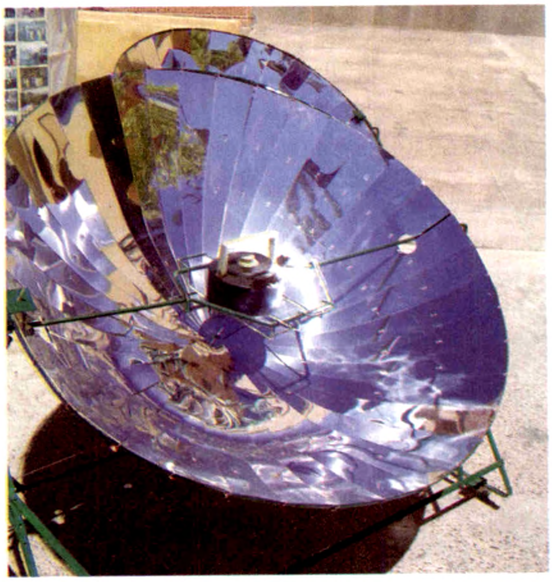
Bharat hot on solar cookers, new energy

This is one announcement that Pranab Mukherjee ought to have made on the floor of the house, but did not do so. At a time when the country is trying to increase its power generation capacity and a large part of the rural areas being unelectrified, Mukherjee has set aside Rs 1346 crore for new and renewable energy. And topping that list would be provision of solar cookers for villages. The MNRE (Ministry of New and Renewable Energy) would deploy 25,000 solar cookers in villages during the year. The ministry's allocation in the interim budget has been increased to Rs 1346 crore from Rs 1147 crore in the revised budget.

According to the annual budget for 2007/08, a total of 6,16,500 solar cookers including over 6,08,500 box-type solar cookers and about 8000 dish solar cookers were deployed during 2006/07.

THE TIMES OF INDIA





Prakritik Urja Puraskar Yojna

The MNRE (Ministry of New and Renewable Energy), Government of India is operating the Prakritik Urja Puraskar Yojna to encourage original book writing in Hindi or translation of books in Hindi in the field of new and renewable energy sources. Under the scheme, there is a provision to award a first prize of Rs 50,000, second prize of Rs 30,000, and a third prize of Rs 20,000 every year. All authors, whether they be government employees or non-governmental persons can participate in the scheme. Entries are invited for the award for the calendar year 2008. The last date for receipt of entries is 31 August 2009. Entries will be accepted in prescribed proforma only. For further details, please contact Dy. Director (OL), MNRE, Block No. 14, CGO Complex, Lodi Road, New Delhi - 110 003 or visit MNRE's website (www.mnre.gov.in).

Vihaan Network unveils world's first solar-powered GSM system

Vihaan Network Ltd, a group company of Shyam Group launched the world's first zero opex GSM systems powered by solar energy rather than conventional sources. The system is expected to save at least 50% of the capex currently involved in setting up base stations, which would lead to further reduction in mobile tariffs. There would be no operating expenditure in running the system. Setting up a solar-powered base station would cost one-tenth the amount currently spent on setting up a base station. Presently it costs as much as Rs 50 lakh to set up a base station.

Apart from saving costs, the system is environment friendly and cleaner. The system is also extremely simple to deploy, is compact, modular, and could be assembled very easily by even illiterate workers.

Hydrogen-run three-wheelers planned for Indian roads

UNIDO's (United Nations Industrial Development Organization)

ICHET (International Centre for Hydrogen Energy Technology) signed a memorandum of understanding with its Indian partners to run three-wheelers on Indian roads on the most advanced and clean fuel: hydrogen. ICHET joined hands with a consortium of partners in India to support, both financially and technically, their efforts to promote use of hydrogen as a fuel for mass transport in Delhi and elsewhere to help check environmental pollution.

Under the project for Delhi, to be called DELHY-3W, a fleet of 15 hydrogen-fuelled three-wheelers would operate at Pragati Maidan in collaboration with the ITPO (India Trade Promotion Organization) to begin with. The $1-million project, half of which is being funded by ICHET, would be operated on a public–private partnership for two years. The hydrogen-operated three-wheelers will be used to transport visitors from the Delhi Metro railway station at Pragati Maidan to the exhibition areas inside the sprawling complex.

UNIDO hopes that the project would support establishment of hydrogen re-fuelling facilities and promote hydrogen vehicles in the capital and gradually spread across India. A formal launch of hydrogen-fuelled vehicles for mass use is expected in mid-2010. The Indian partners of the project include IIT-Delhi (Indian Institute of Technology-Delhi), Mahindra and Mahindra, and Air Products, while the foreign collaborators are the United Nations, ICHET-Istanbul, and the UNIDO Regional Office for South Asia.

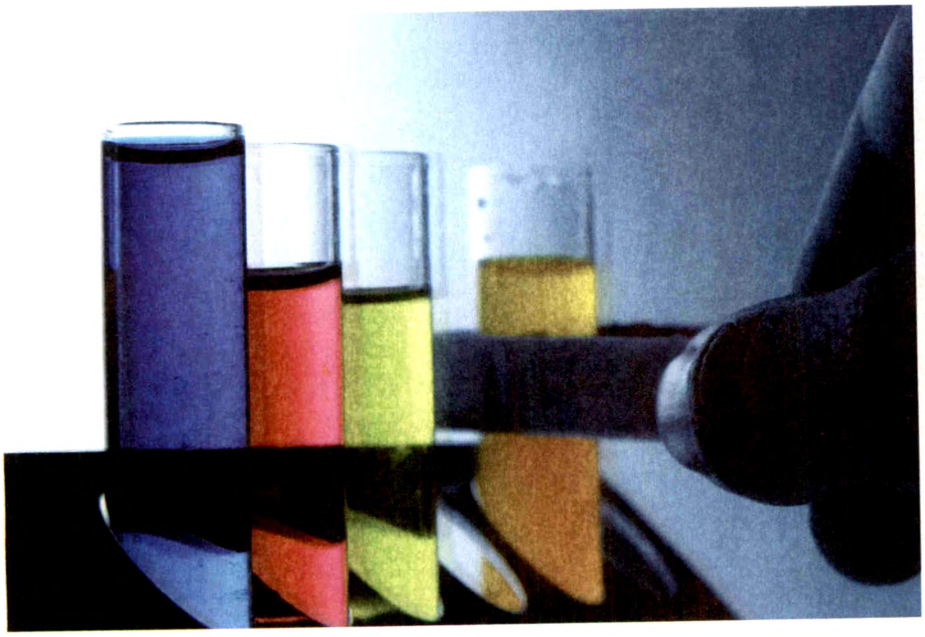
The consortium will be coordinated by Prof. L M Das of IIT-Delhi, a specialist in alternative fuels and hydrogen engines. Mahindra and Mahindra will build the hydrogen three-wheelers while Air Products will provide hydrogen fuelling. UNIDO India will be completing the consortium undertaking dissemination and liaison activities. The Turkey-based ICHET, funded by the Turkish Ministry of Energy, aims at supporting developing countries leap-frog to hydrogen, the cleanest energy carrier, by helping the development and demonstration of such technologies through support to universities and industries.

THE HINDU

CIIE encourages innovation in renewable energy

The CIIE (Centre for Innovation, Incubation, and Entrepreneurship) at the IIM-A (Indian Institute of Management, Ahmedabad) has joined hands with the MNRE (Ministry of New and Renewable Energy), Government of India to encourage research and innovation in renewable energy. With the programme called renewable energy search, CIIE and MNRE propose to identify, encourage, and incubate entrepreneurial ideas aimed at solving the energy crisis through creation of viable business models around existing clean energy related technologies.

The programme aims at commercializing scaleable existing technologies developed by researchers, individual inventors, start-ups, and large corporations across



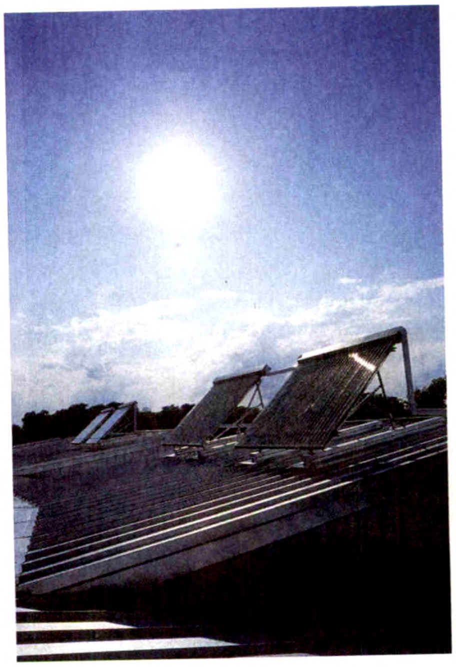
the world through creation of viable business around it. The programme shall provide support recognition, licensing, seed funding, and mentoring to the start-ups, entrepreneurs in residence, and innovators. 'The programme shall provide funding and mentoring support to technology-based start-ups. CIIE shall make an investment of up to Rs 20 lakh per start-up over the next few months. It will either directly fund or help raise further round of investment in the companies. For entrepreneurs, besides helping them set up, the most viable plans shall be provided funding and incubation support. The work of innovators, researchers at institutes, corporations, and individuals interested in commercializing their research shall be considered for the top innovator awards comprising a cash prize of Rs 5 lakh, apart from incubation and funding,' said Kunal Upadhyay, Chief Operating Officer, CIIE.

'Deployment is most crucial in the clean energy value chain. Through our strong network, we hope to be able to handhold these clean energy technologies and start-ups during their gestation period and quickly test their products into the market through creation of unique business models. This programme provides the perfect launch pad for all clean energy start-ups,' says Pranay Gupta, Joint CEO, CIIE.

THE TIMES OF INDIA

Delhi Metro goes green with solar power

The Delhi Metro is turning more eco-friendly with installation of solar panels for electricity at its headquarters, which will prevent 2.35 tonnes of GHG (greenhouse gas) emissions per year. The 64-panel, 5-kW (kilowatt) solar power plant installed at the Metro Headquarters in Connaught Place can generate 15 kWh (kilowatt-hour) of electricity per day, Delhi Metro spokesperson Anuj Dayal said. The solar power plant presently caters to the need of lighting electrical equipments including the terrace lightings at the Metro Bhawan from dusk to dawn. Installed at a cost of about Rs 20 lakh on an experimental basis, the 5-kWp SPV (solar photovoltaic) power plant includes the crystalline silicon SPV modules, a maintenance-free battery bank of 1000-Ah (ampere-hour) capacity, charge controller, and an inverter.



THE FINANCIAL EXPRESS

Philips set to go rural with solar products

Philips Electronics India is set to launch made-in-India products like solar and battery powered lanterns, rechargeable and fuel-efficient wooden stoves, and torches that run without a battery to cater to the rural population. This falls in line with the parent company's aim to increase its presence in the emerging markets like India, China, Brazil, and Russia that contribute about 30% of its overall revenues and also diversify from consumer lifestyle products. 'We will launch new categories with low-cost solutions made in and for India to cater to the rural market and smaller towns in India,' said Murali Sivaraman, Chief Executive Officer, Philips Electronics India.

The first product in the range would be a Rs 1000 solar lantern designed in India, and will hit the market in a month or so. The company also plans to launch in the next three months a new category

of wooden stoves based on renewable resources – like a rechargeable one that will have a fan to remove the smoke and another that will work on natural air – both priced between Rs 1000 and Rs 2000. 'The upcoming products will be in the range of Rs 1000 to Rs 2500 and we have been in talks with the government over the last few months for subsidizing and promoting the products,' Rakesh Sharma, Senior Director, Strategy and Business Development, Philips Electronics India said.

HINDUSTAN TIMES

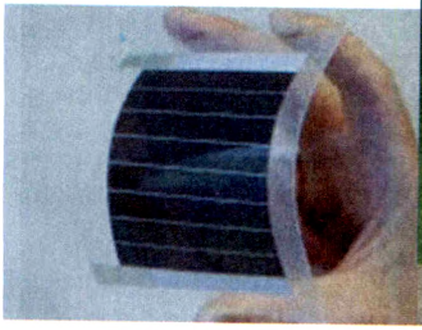
Numeric ventures into green energy solutions

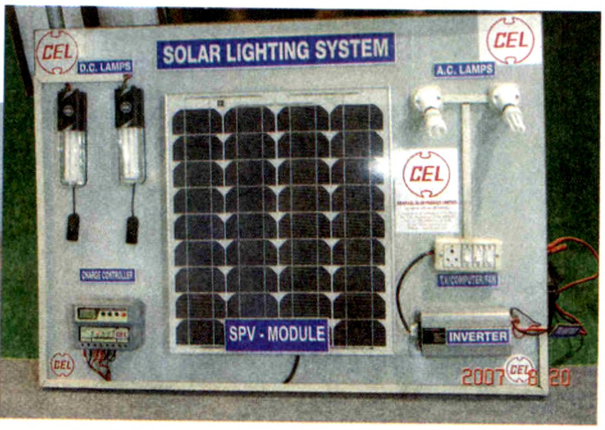
Numeric Power Systems, a leading provider of UPS (uninterrupted power supply) systems, has ventured into green energy solutions such as solar power systems, wind energy generation, and LED lighting systems. Shri R Chellappan, Managing Director, said the company was offering specialized and standard solar product range under the renewable energy programme combined with energy-efficient LED lighting solutions for a wide range of applications.

Recently, the company has floated a fully owned subsidiary — Numeric Solar Energy Pvt. Ltd — to offer these products. The solar energy products include amorphous and crystalline SPV (solar photovoltaic) panels and solar charge controllers ranging from 12 V (volts) to 196 V while the green energy products include LED decorative systems and customized LED lighting solutions. The fabrication plant near Chennai has 96 kWp (kilowatt-peak) of solar power generation system while the transformer and stabilizer plant at the same location has installed solar panels for producing 20.16 kWp.

Besides, the company has facilities at Salem for 9.6 kWp of solar power. It is also implementing a project for 100.8 kWp in the same location. According to Shri K V Nachiappan, a director, the company was planning to develop megawatt range of solar energy systems within the wind energy farm already owned by it in Palladam, near Coimbatore in Tamil Nadu.

THE HINDU





India calls for renewable energy partnership with the US

With the Obama Administration focusing on clean and renewable energy, India has sought partnership with the US in the field to meet the growing challenge of climate change. Such a partnership between the two countries, after the civilian nuclear deal, is essential to jointly meet the challenges of climate change, Shyam Saran, the Prime Minister's Special Envoy on Climate Change, told a meeting of US corporate leaders organized by the USIBC (United States India Business Council).

USIBC had played a significant role in the passage of the Indo-US civilian nuclear deal, despite tough hurdles. Welcoming President Obama's Renewable Energy Initiative, Saran said, 'The first component of our strategy for the future, for both Indian and US business is a renewable energy partnership covering different technological pathways and focusing on technology and product development.'

Asserting that the world is on the cusp of an energy revolution, Saran said it is becoming apparent that current trends of growth of the global economy, in particular the growth of India and China, cannot be sustained by the accelerated depletion of fossil fuels. 'If energy is not to become a constraint on our growth -- the growth of India and the US and the global economy as a whole, then a relatively rapid and significant shift to renewable and non-conventional energy sources becomes inevitable. Both climate change action and energy security dictate this,' he said.

'We should explore how we could use flue gas from coal-based power plants to produce methane which may be used as transportation fuel. The ideal should be to create a world in which production and consumption processes are closed cycles with zero waste,' he argued.

THE FINANCIAL EXPRESS

Micro hydel project in village Tikat, Kargil

Signing memorandum of understanding

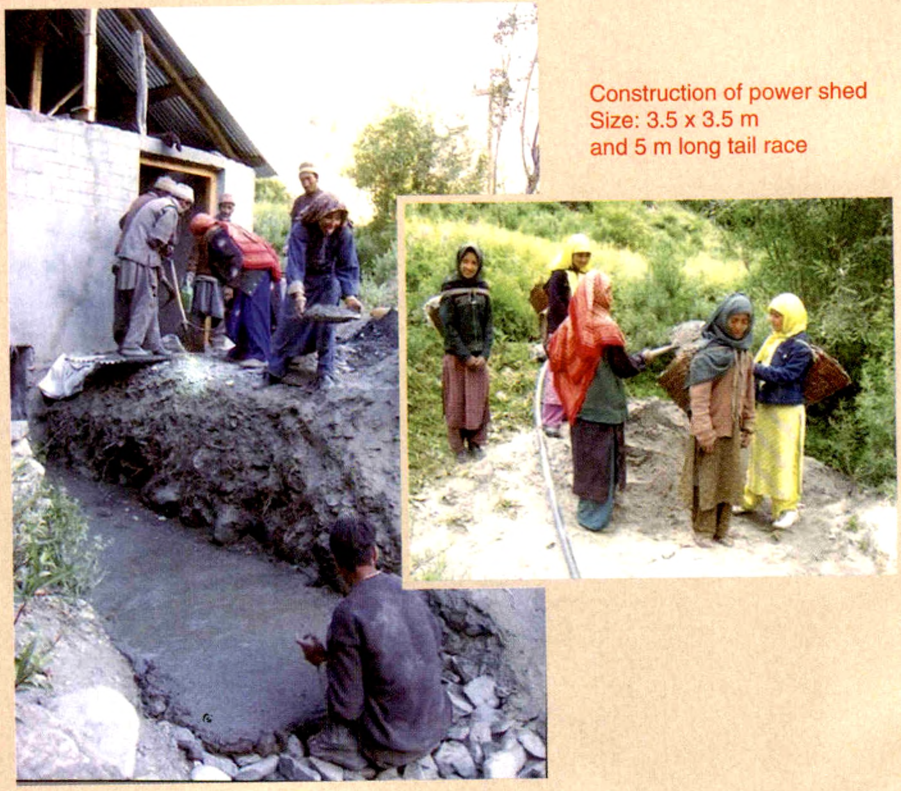
Tikat is a very remote village in district Kargil having a hilly terrain surrounded by large ranges such as Zanskar and Ladakh running parallel to the Himalayas. These ranges are drained by a number of rivers, which eventually end up in the Indus and become permanently snow covered. The village receives negligible rainfall. A 30-kW micro hydel project was commissioned in the village by the Directorate of Science and Technology (IREP) J&K state. The project was installed at an estimated cost of Rs 11 lak at Sankoo Nallah. The project provided electricity to 79 households in the village.

The project cost included the cost of distribution network as also the cost of service lines from the transmission line to the individual households. It is run by the village energy committee through two grass-roots engineers who have been trained in the maintenance of such projects and been associated from day one in the construction. Each beneficiary contributes Rs 20 per month and this amount is shared between the two engineers.

This project has opened a new phase in this remote village and opened avenues for other economic development activities. The project necessitated an expenditure of Rs 0.33 lakh only as maintenance cost during the expeditious use of the project for the last 4–5 years now.

PROJECT DIRECTOR (IREP),

SCIENCE AND TECHNOLOGY DEPARTMENT



Construction of power shed
Size: 3.5 x 3.5 m
and 5 m long tail race

Photo courtesy: DOE/NREL

Swearing by the magic wand of $1/Wp

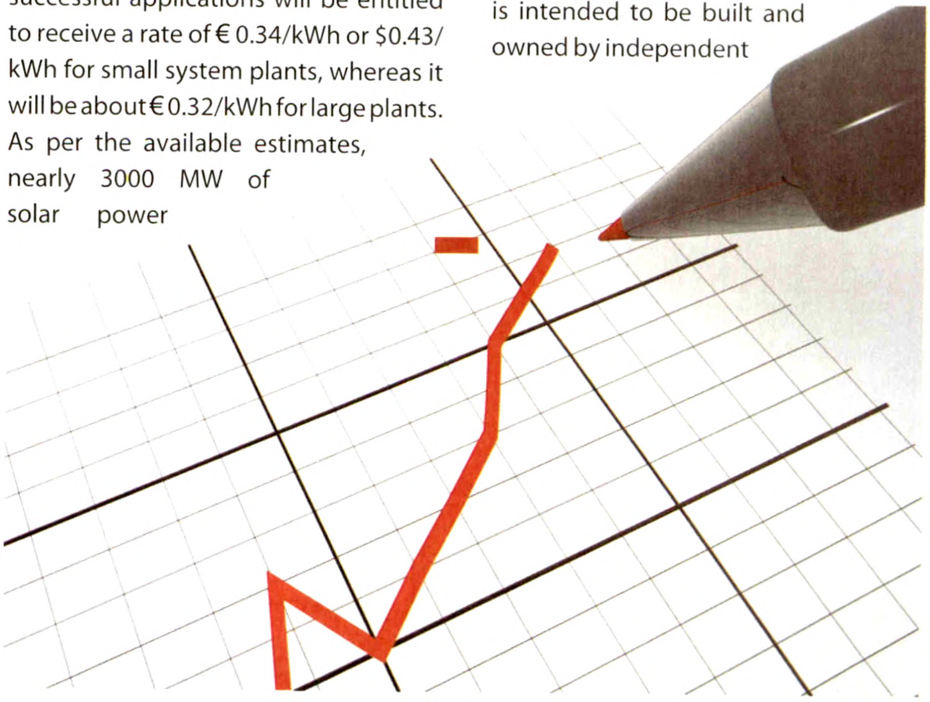
First Solar, as the name suggests, may well be on its way to finally achieve a revolutionary selling price of less than $1 per peak watt for modules some day. The company is now quite upbeat about having reduced its manufacturing cost for solar modules in the fourth quarter to $0.98/Wp. It aims to showcase a growing capability of the thin-film technology to rival the conventional power producing technologies more so for tackling a key challenge of climate change. This innovative manufacturing initiative came into being in late 2004. Between then and now, the manufacturing capacity has grown 2500% with a capacity of 2500 MW achieved in 2008. Its annual capacity is expected to double in 2009 to about 1000 MW. The positive gain has been in terms of bringing down the manufacturing cost considerably. In fact, the company has managed to cut down its costs by two-thirds from over $3/watt to less than $1/watt. Further reduction is expected on the basis of further changes in the production process.

Spain setting up a new feed-in-tariff

The National Energy Commission of Spain has received a huge response from about 392 applicants who wish to qualify for the country's new solar projects specific feed-in-tariff level. The successful applications will be entitled to receive a rate of € 0.34/kWh or $0.43/kWh for small system plants, whereas it will be about € 0.32/kWh for large plants. As per the available estimates, nearly 3000 MW of solar power projects were connected to the national grid between January and November previous year. The overwhelming response to the renewed tariff scheme is being seen as a sure indicator of its being attractive and stable too. In terms of the actual market growth, the country's solar market expanded three-fold going well past the estimates made by the market analysts. Till date, only about 2000 MW of the total installations have been grid connected and stand registered with the Spanish government.

Majoring with a mega solar power initiative

The PG&E (Pacific Gas and Electric Company) has recently made public its plans of a five-year initiative to develop about 500 MW of SPV power. The northern and central California service areas have been chosen for the purpose. The proposed programme involves setting up of 250 MW of utility owned PV generation, which is its first direct investment in renewable generation in over a decade. Another 250 MW of the capacity is intended to be built and owned by independent



developers under a streamlined regulatory process. These plans have to go through the approval process of California Public Utilities Commission later this year. As per available projections, more than 1000 GWh of power is expected to be delivered by 2015. These may well fulfill the needs of nearly 150 000 homes.

In totality, it may help to meet about 1.3% of the PG&E's electric demand. The company programme focuses on mid-sized projects, typically 1–20 MW capacity set up either on ground or using available roof space. One of the unique features is that the projects are earmarked at sites (that is, land), which PG&E already owns. If not, it is possible that these are put up in the vicinity of sub-stations to cut down the cost and time of interconnecting them to the power grid. It had already announced its intention to purchase the outputs of two SPV power plants with an aggregated capacity of 800 MW.

Sunshine to cheer about in US

Not everything is getting costly—at least not the cost of SPV systems installed in US. The installed costs have taken a dip of more than 28% in the last decade or so. It is based on a just released study of the LBNL (Lawrence Berkeley National Laboratory). As per the study, the cost of solar systems meant for commercial applications are declining faster than those for the residential purposes. The cost of installing such systems dropped from $10.50 per watt in 1998 to $7.60 per watt in 2007. The percentage reduction has amounted to nearly 3.5 per year with the costs having remained relatively flat in 2006 and 2007. These calculations do not include any cash rebates or tax credits as such. The research group of Ryan Wiser, Galen Barbose, and Carla Peterman used data from about 37 000 grid-connected SPV systems spread over 12 states. Arizona recorded the lowest cost in the capacity range of 10 kWp followed up closely by California and New Jersey. These findings are reported in the document, *Tracking the sun: the installed cost of photovoltaics in the US from 1998–2007*.

It is important to mention here that the solar panel prices made a little contribution to cost reduction. Instead, the cost on account of inverters, labour, and marketing amongst others made these installations cheaper. In figurative terms, the non-module costs came down from $5.7 per watt in 1998 to $3.6 per watt in 2007. It has also been observed that states with strong incentive programmes also tend to have more companies competing for providing installation and other services. Of all the states, Arizona, California, and New Jersey offer more generous tax and cash incentives. This resulted in Arizona recording the lowest cost (in the 10 kWp category) of $7.60/Wp followed up closely by California ($8.10/Wp) and $8.40/Wp for New Jersey. For 10-kWp systems deployed during 2006/07, thin-film panels cost on average $0.5/Wp more than those using crystalline silicon panels. However, the difference was not significant for system sizes in excess of 10 kWp. Other key summary results are as under.

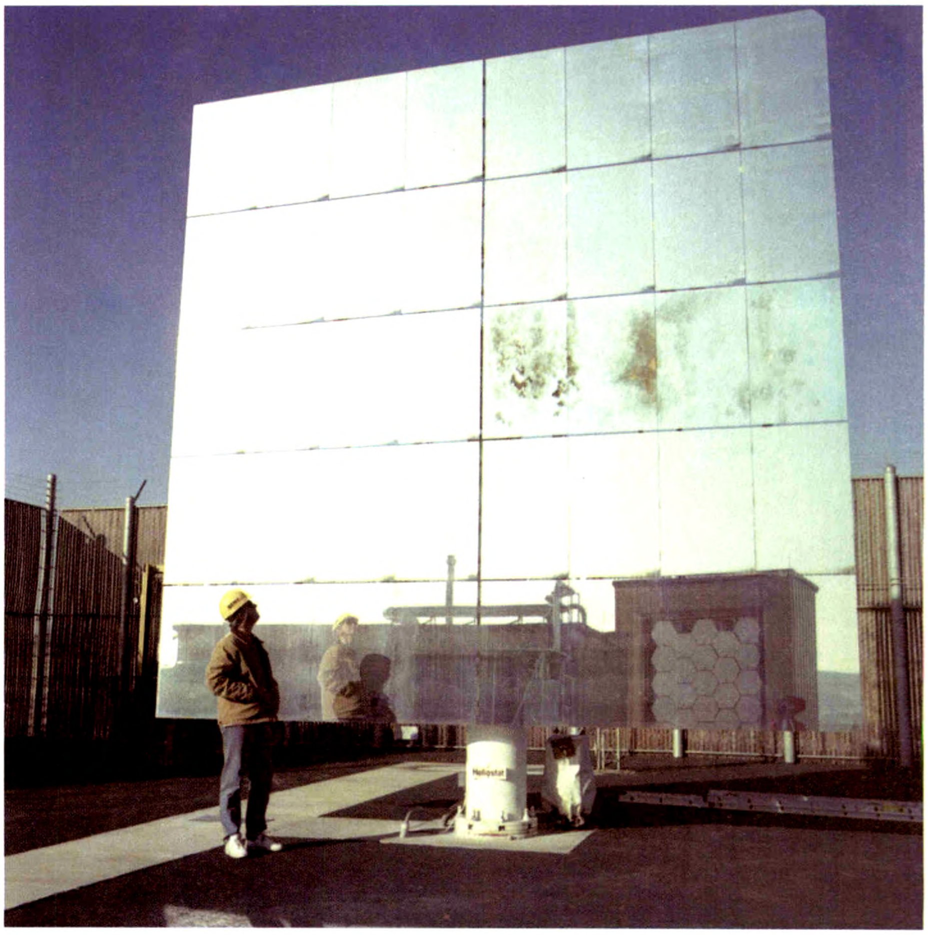
- The net cost of putting up a residential PV system (taking into account all available private, state, and federal incentives) touched an average of $5.1 per watt in 2007.
- The above cost is about 7% less than the 2001 levels.
- The net cost for a commercial system averaged $3.9 per watt in 2007—a sizeable 32% less than the 2001 levels.
- Costs for all types of systems remained flat between 2005 and 2007.
- Cost reduction of 5%–20% or even more expected in the solar module prices in the current year.

Speed breakers to go green

'Green' speed bumps that will generate electricity as cars drive over them are to be introduced on Britain's roads. The hi-tech 'sleeping policemen' will power streetlights, traffic lights, and road signs in a pilot scheme in London that could be rolled out nationwide. Speed bumps have long been the bane of motorists' lives, but these will capture the kinetic energy of vehicles. Peter Hughes, the designer behind the idea, said, 'They are speed bumps, but they are not like conventional speed bumps. They don't damage your car or waste petrol when you drive over them—and they have the added advantage that they produce energy free of charge.

The ramps, which cost between £20,000 and £55,000, depending on size, consist of a series of panels set in a pad virtually flush to the road. As the traffic passes over it, the panels go up and down, setting a cog in motion under the road. This then turns a motor, which produces mechanical energy. A steady stream of traffic passing over the bump can generate 10–36 kW of power. The bumps can each produce between £1 and £3.60 of energy an hour up to 16 hours a day, or between £5840 and £21,024 a year. Energy not used immediately can be stored or fed into the national grid. Hughes claims that 10 ramps could generate the same power as one wind turbine.

DECCAN HERALD



First carbon-free polar station opens

The world's first zero-emission polar research station opened in Antarctica and was welcomed by scientists as proof that alternative energy is viable even in the coldest regions. Pioneers of Belgium's Princess Elisabeth station in East Antarctica said of a station could rely on wind and solar power in Antarctica – mostly a vast, icy emptiness – it would undercut arguments by skeptics that green power is reliable. 'If we can build such a station in Antarctica we can do that elsewhere in our society. We have the capacity, the technology, the knowledge to change our world,' Alain Hubert, the station's project director said.

Global warming, spurred by greenhouse gas emissions, has prompted governments to look for alternative energy sources. And renewable energies are gaining a foothold in Antarctica, despite problems in designing installations to survive bone-chilling cold and winter darkness.

Constructed over two years, the steel-encased station uses micro-organisms and decomposition to enable scientists to re-use shower and toilet water up to five times before discarding it down a crevasse. Wind turbines on the Utsteinen mountain ridge and solar panels on the bug-like, three-storey building ensure that the base has power and hot water. Even the geometry of windows helps conserve energy.

BUSINESS LINE

World's first solar-powered film premieres in London

A new film warning of the devastating effects of climate change was screened in London in what organizers said was the world's first solar-powered premiere. Oscar-nominated British actor Pete Postlethwaite stars in 'The Age of Stupid', which was shown in a solar cinema tent in Leicester Square and beamed to more than 70 cinemas nationwide via a live satellite link. The event's organizers said they hoped that up to 16,000 people would watch the premiere—but discouraged anyone from flying to London to see it.

Postlethwaite turned up in a solar car to the premiere, which was also attended by actress Gillian Anderson, Designer Vivienne Westwood – on a bicycle – and Energy and Climate Change Secretary Ed Miliband. In the film, Postlethwaite plays an old man living alone in a devastated 2055, looking back on archive footage of 2008 and asking why no one acted to stop climate change. 'The Age of Stupid', which opens here on 20 March 2009, took 3.5 years to make and had a budget of just 450 000 pounds (500 000 euros, 630 000 dollars) provided by 228 individual investors.

WWW.SOLARDAILY.COM

Alternative fuel vehicles from China

About 60,000 alternative-fuel vehicles are expected to be on China's roads by 2012 as part of the efforts to save energy and reduce emissions, according to the Minister of Science and Technology Wan Gang. Most of these vehicles would be used for public transport, Mr Wan told an international forum on energy conservation and new energy development. Also, large-scale use of LED lighting would be promoted in dozens of big Chinese cities and the use of solar and wind energy would be accelerated, he said.

He said China, as a large developing country undergoing rapid industrialization, faced the pressures of promoting growth while saving resources and protecting the environment. He said China had made saving energy, reducing emissions, and using renewable energy sources as a strategic plan to achieve sustainable development. China would use various means to provide financial support to small- and medium-sized companies involved in energy conservation and environmental protection. It would also give tax benefits and direct subsidies to the production, sale, and use of alternative-energy vehicles and 'green' home appliances, he said.

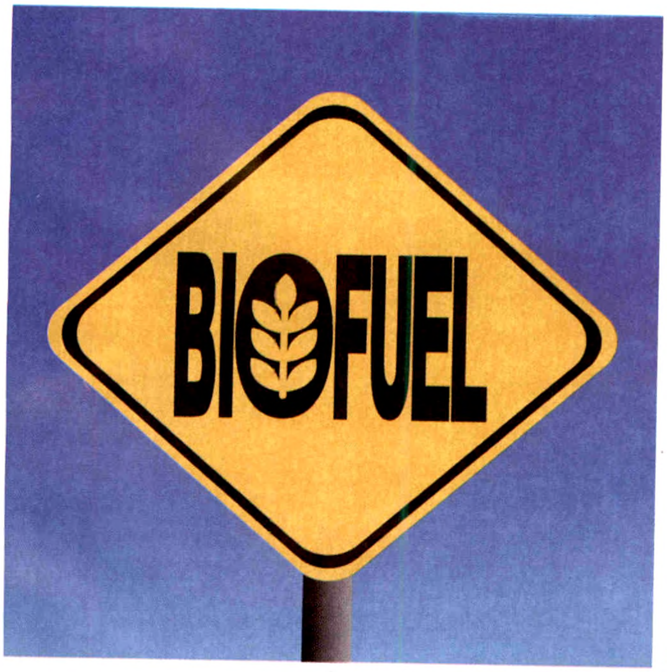
THE HINDU

EU to impose duties on US biofuels

The EU (European Union) is preparing to impose trade duties on biofuels imported from the US (United States) to prevent American producers from putting European producers of bio-diesel out of business. Biofuels are developing into a big business, with annual sales of about $10 billion, in Europe and with imports of bio-diesel from the US worth about one billion dollars. The EU and US generally subsidize their bio-diesel industries. But European producers complain that producers in the US benefit twice from subsidies granted by individual European governments when it is sold in Europe.

EU trade officials began a formal investigation last year, after European biofuel producers complained about unfair support for American producers. EU officials said they suspect that the subsidies consist of federal excise and income tax credits along with a federal programme of grants for increases in production, as well as various subsidies from state governments.

DECCAN HERALD



Creating a mini sun for clean energy

Scientists are to use the world's most powerful laser system to replicate the fiery core of the sun in experiments that may ultimately offer humanity a clean source of energy. After more than 50 years of experimentation, physicists are hoping to develop the first form of nuclear vision technology that produces more energy than it consumes. Within the next fortnight, researchers at the NIF (National Ignition Facility) in California will fire 192 separate laser beams capable of generating 500 trillion watts – 1000 times the power of the US national grid – for a fraction of a second. The energy pulse will be concentrated on a tiny pellet of hydrogen in an attempt to mimic the reactions that take place inside the sun. The scientists hope to refine the process over the next year until they trigger a nuclear reaction capable of producing large amounts of energy.

THE TIMES OF INDIA

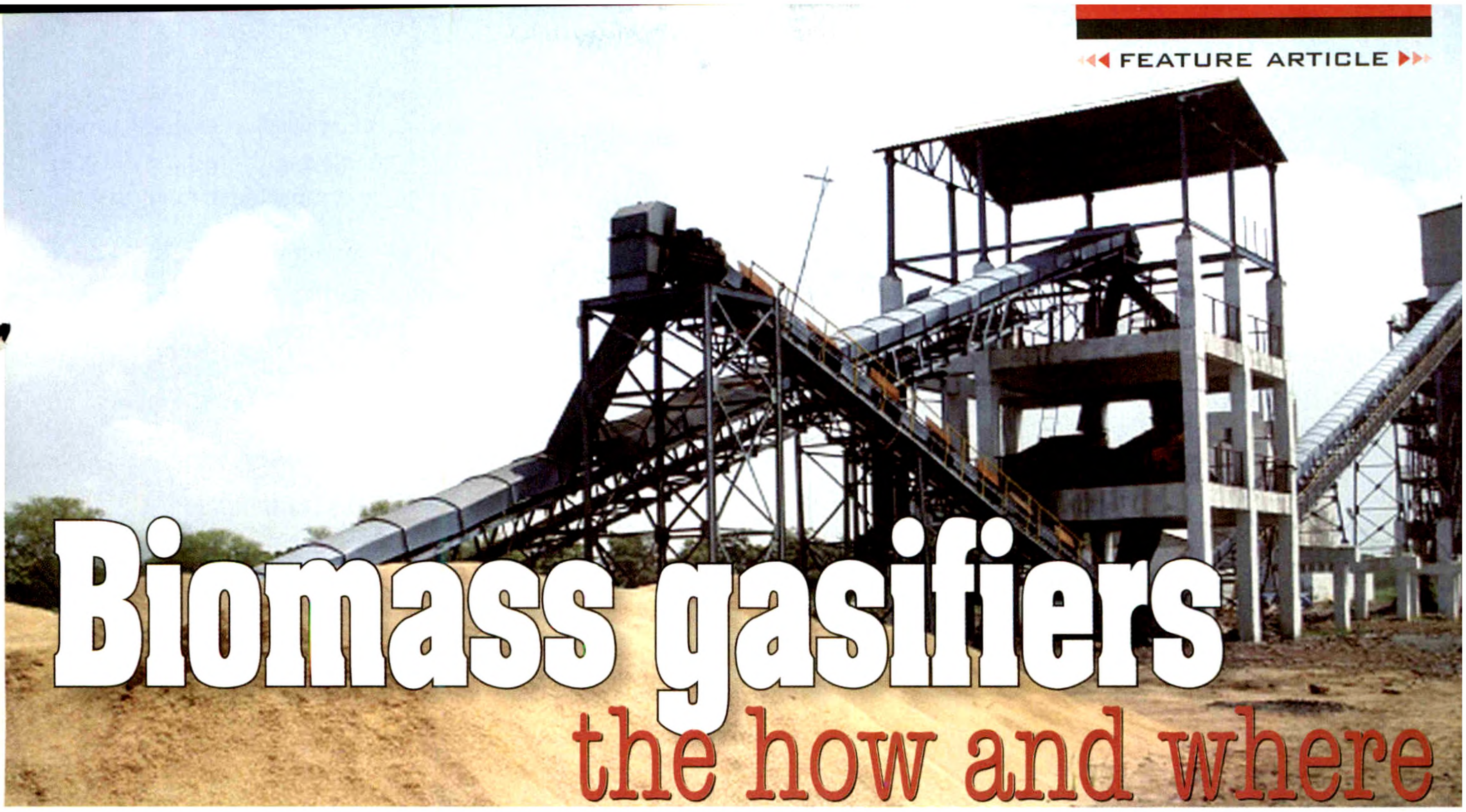
Doing wonders with mirrors

Here is a retired government official who does not bother about power cuts. He has found an economical way of bringing 'light' to his home during daytime. And the method is very simple: sunlight reflected through mirrors. His 'Save Electricity Mission' is on since many years and his innovative idea of harnessing sunlight for lighting up poorly ventilated homes has received the World Bank's appreciation. Meet 65-year-old Vasanthkumar Mysoremath, a resident of Tilaknagar in Mysore, the man who does wonders with mirrors. With no respite from load shedding, using daylight to brighten the interiors of homes can work as an alternative. 'Let us bring home the sunlight. Let us stop misusing electricity during the day,' is Mr Mysoremath's mantra.

Being a tropical peninsular landmass, south India is blessed with a minimum of 200 days of bright sunlight. Most of the houses do not provide for proper design for entry of natural sunlight. He says people can get free light from the sun during those six hours without electricity. How? 'It's very simple,' says Mr Mysoremath. The method is to fix a household mirror/reflector measuring 1′ x 1.5′ inside a bucket at an angle and place it where the sunlight falls, keep a brick inside the bucket so that it remains stationary, nudge the mirror/reflector or prop it up with waste thermocol pieces to adjust the angle and to reflect sunlight on to the white ceiling inside the house through the window or door. The ceiling will reflect evenly the bright light inside the entire room.

A little moving of the bucket will be necessary periodically to bring back the sunlight on to the ceiling, he explains. 'It is worth the effort because one can get bright light inside dark houses. On the flip side, such bright light has the capacity to destroy house mites,' he says. This innovative model titled, 'Unlimited Saving of Electrical Energy' or U-SEE, entered the final round of the second India Development Marketplace (IDM) 2007 competition, which was organized by the World Bank's New Delhi office to get innovative ideas from the grass-roots level for preserving natural resources.

Mr Mysoremath has received a certificate from the World Bank and a knowledge grant of Rs 20,000 for his idea on saving power.



Biomass gasifiers
the how and where

DR A K TRIPATHI, Director, MNRE

Biomass has been one of the main energy sources for mankind ever since the dawn of civilization although its importance dwindled after the expansion in use of oil and coal in the late 19th century. There has been a resurgence of interest in the recent years in biomass energy in many countries considering the benefits it offers. It is renewable, widely available, and carbon neutral and has the potential to provide significant productive employment in the rural areas. Biomass is also capable of providing firm energy. Estimates have indicated that 15%–50% of the world's primary energy use could come from biomass by the year 2050. Currently, about 11% of the world's primary energy is estimated to be met with biomass.

For India, biomass has always been an important energy source. Although the energy scenario in India today indicates a growing dependence on the conventional forms of energy, about 32% of the total primary energy use in the country is still derived from biomass and more than 70% of the country's population depends upon it for its energy needs.

The Government of India through the MNRE (Ministry of New and Renewable Energy) has been aware of the potential and role of biomass energy in the Indian context and hence has initiated a number of programmes for promotion of modern technologies for its use in various sectors of the economy to ensure derivation of maximum benefits. Biomass power generation in India is an industry that attracts investments of over Rs 600 crore every year, generating more

than 5000 million units of electricity and yearly employment of more than 10 million man days in the rural areas. The three main technologies being promoted by the MNRE for productive utilization of biomass are bagasse-based cogeneration in sugar mills, biomass power generation, and biomass gasification for thermal and electrical applications.

Biomass gasification for thermal and electrical applications

What is biomass gasification?

Biomass gasification is thermo-chemical conversion of solid biomass into a combustible gas mixture (producer gas) through a partial combustion route with air supply restricted to less than that theoretically required for full combustion. Typical composition of producer gas is as follows.

Carbon monoxide	18%–20%
Hydrogen	15%–20%
Methane	1%–5%
Carbon dioxide	9%–12%
Nitrogen	45%–55%
Calorific value	1000–1200 kCal/m^3

Why gasify biomass?

- Producer gas can be used as a fuel in place of diesel in suitably designed/adopted IC (internal combustion) engines coupled with generators for electricity generation.
- Producer gas can replace conventional forms of energy such as oil in many heating applications in the industry.
- The gasification process renders the use of biomass relatively clean and acceptable in environmental terms.
- Large monetary savings can accrue through even partial substitution of diesel in existing DG (diesel generator) sets.

What type of biomass can be gasified?

Most commonly available gasifiers use wood/woody biomass; some can use rice husk as well. Many other non-woody biomass materials can also be gasified, although gasifiers have to be specially designed to suit these materials and the biomass may have to be compacted in many cases.

Typical capacities

Biomass gasifier based systems are being made in capacities ranging from few kilowatts to a megawatt of electricity equivalent. For heating applications, the current upper limit on the unit size is equivalent to 200–300 kg/hour of oil consumption.

Costs

The typical costs of biomass gasifier based power generation systems range from Rs 4 crore per MWe to Rs 4.5 crore per MWe. The cost of electricity generation depends upon the cost of biomass, plant load factor, and so on and is estimated to be between Rs 2.50/kWh (kilowatt-hour) and Rs 3.50/kWh. For thermal applications, the capital costs

are estimated to be about Rs 0.5–0.7 crore for each one million kCal capavity.

Financial incentives

Central financial assistance/grants-in-aid being provided under the MNRE programme are given below. For further details visit <www.mnre.gov.in>.

Capital subsidy

1. Biomass gasifier for thermal and electrical applications in industry
   i) Rs 2 lakh/300 kWth for thermal applications.
   ii) Rs 2.50 lakh/100 kWe for electrical applications through dual fuel engines.
2. Biomass gasifiers coupled with 100% producer gas engine in industry.
   i) Rs 10 lakh/100 kWe for 100% producer gas engine with gasifier systems.
   ii) Rs 8 lakh/100 kWe for 100% producer gas engine alone.
3. Institutional gasifier systems
   i) Rs 15 lakh/100 kWe for 100% producer gas engine coupled with gasifier system.
   ii) Rs 10 lakh/100 kWe for 100% producer gas engine alone.
4. Capital subsidy for biomass cogeneration (non-bagasse) projects.

Capital subsidy at the rate of Rs 20 lakh/MWe would be provided to promoters for installation of biomass cogeneration (non-bagasse) projects, including captive projects based on direct combustion.

Technology and equipment

There are about a dozen known manufacturers in the country for gasification systems. A list of these manufacturers is given below.

Dr B C Jain, Managing Director
Ankur Scientific Energy Technologies Pvt. Ltd
Near Old Sama Jakat Naka, Vadodara – 390 008
Tel. 793 098, 794 021 • Fax (0265) 794042
E-mail ascent@wilnetonline.net

Mr G M Satyanarayana, Managing Partner
Associated Engineering Works
P B No.17, Gamini Compound, Chivatam Road
Tanuku – 534 211
Tel. 08819 22950 • Fax 08819 24801

Mr BV Ravi Kumar, Director
M/s Cosmo Powertech Pvt. Ltd
Devpuri, Near Jain Public School
Dhamtari Road, Raipur – 492 015
Tel. 0771 501 1262 • Fax 0771 501 0190
E-mail cosmo_powertech@yahoo.co.in

Mr J Mukherjee, Director
Grain Processing Industries (I) Pvt. Ltd
29, Strand Road, Calcutta – 700 001
Tel. (033) 243 1639/210 1252
Fax 91 33 220 4508/210 3368

Dept of Aerospace Engineering
Indian Institute of Science
Bangalore – 560 012
Tel. 080 2334 8538, 2309 2338
Fax 080 2334 8536/1683

Mr K Ramachandra
M/s Netpro Renewable Energy (India) Ltd
139/B, 10th Main, Rajamahal Vilas Extension
Bangalore – 560 080
Tel. (080) 361 3585, 361 3457
Fax (080) 361 1584 • E-mail netpro1@vsnl.com

Mr Sudhir Chandra
M/s Chanderpur Works
Yamuna Nagar – 135 001, Haryana
Tel. 01732 250 546, 250 964, 251 866
Fax 01732 279 852
E-mail sudhiryn@sancharnet.in

Mr Naval Kishore Agarwal
Infinite Energy Pvt. Ltd
149-A, Baba House, 1st Floor, Kilokari,
Opp. Maharani Bagh, New Delhi – 110 014
Tel. 011 6527 3819 / 6519 1937
Fax 011 2690 3696
E-mail ifnfinitenergy@vsnl.net
Web www.infiniteenergyindia.com

Shri H R Jaiswal, Managing Director
Rishipooja Energy and Engineering Company
M G College Road, Gorakhpur – 273 001 (UP)
Tel. 0551 340 612, 339 475

Shri K J Haris, Managing Director
Southern Carbons (P) Ltd.
Palackal Buildings, Premier Junction
Kalamassery – 683 104, Cochin, Kerala
Tel. 0484 540 158 (O) 532 685 (F) 532 684®
Fax 0484 532 179
E-mail southerncarbons@indianbest.com

Dr S V Makadia, President
Radhe Renewable Energy Development
Associate, D-110 Rajdoot Industrial Estate
4, Umakant Pandit Udyognagar
Near Mavdi Plot
Rajkot – 360 004 (Gujarat)
Tel. 91 981372567 (O) 571932
Fax 91 281372557
E-mail radheengineering@radhegroup.com

Shri Ashok Mourya
Agro-power Gasification Plant Pvt. Ltd
B37/181, B1, Birdopur, Varanasi – 221 010 (UP)
Tel. 0542 236 4285 • M 9415221537

Mr Navin Raheja, Managing Director
OVN Bio Energy Pvt. Ltd
BT 1/90, Mangolpuri Industrial Area, Phase-1
New Delhi - 110083
Tel. 91 11 2791 1603, 2791 1608
Fax 2791 6379
E-mail gasifier@ovntepl.com

Disclaimer: Inclusion in this list does not imply approval or recommendation of any company or its products by the Ministry of New and Renewable Energy

Moving ahead in renewable power generation

Introduction

The oil shock of late 1970s prompted energy planners world over to look for alternative sources of energy. Proper utilization of renewable energy such as solar, biomass, and wind once again started capturing the imagination of mankind. It was realized that sustainable development of the country called for growth of energy sector with effective management and proper mix of available renewable and non-renewable sources of energy. The Government of India set an example as one of the few countries that created independent ministry for renewable energy, the MNRE (Ministry of New and Renewable Energy) in the early 1980s. In line with the central government policy, the renewable energy namely MNRE in early 1980s. In line with the central government policy, Maharashtra created MEDA (Maharashtra Energy Development Agency).

Registered as a Society on 26 July 1985, MEDA as an organization commenced functioning from July 1986. MEDA's objective is to undertake development of renewable energy and facilitate energy conservation in the state of Maharashtra, as a state nodal agency under the umbrella of the MNRE. Apex controlling body of MEDA is the governing body with the Minister of Non Conventional Energy, Maharashtra state, as Chairman. For about a decade since its establishment, MEDA did extensive work in the field of renewable energy focusing on rural areas and stand-alone devices. IREP (Integrated Rural Energy Planning) programme was the main plank of its activities.

Shri. Mahesh Zagade, Director General, MEDA, (extreme right) receiving IEEMA Power Award 2009- 1st Prize in the category "Excellence in Renewable Energy Development – Biomass" for Maharashtra at New Delhi on 24th February, 2009

However, in the last few years, technologies of generation of grid-connected power from renewable sources have matured and were become popular in India. Accordingly, MEDA has undergone organizational restructuring from a largely rural 'stand alone system' oriented organization to a significant player in the field of generation of power from renewables. Generation of power from environment friendly resources has become the main focus.

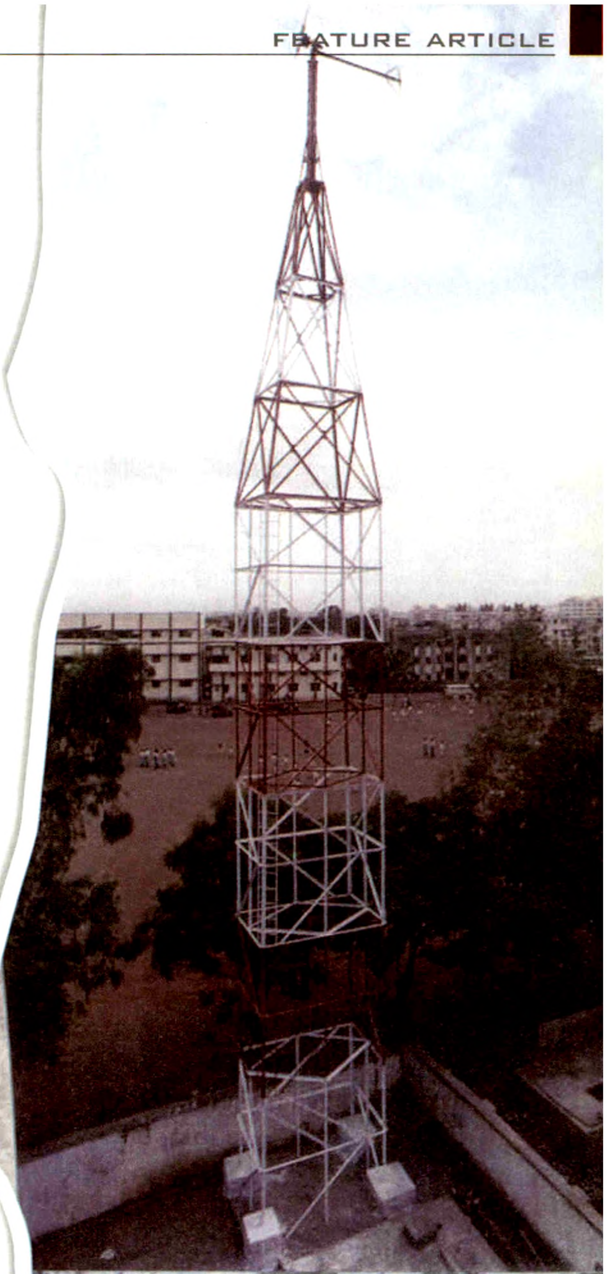
To undertake this onerous responsibility, MEDA has positioned itself as an organization with enough financial and human capabilities having a professional organizational structure. We have also undertaken extensive human resource development activities and have created a modern working environment for our staff. Our office uses renewable energy sources: a wind–solar hybrid stand alone power system.

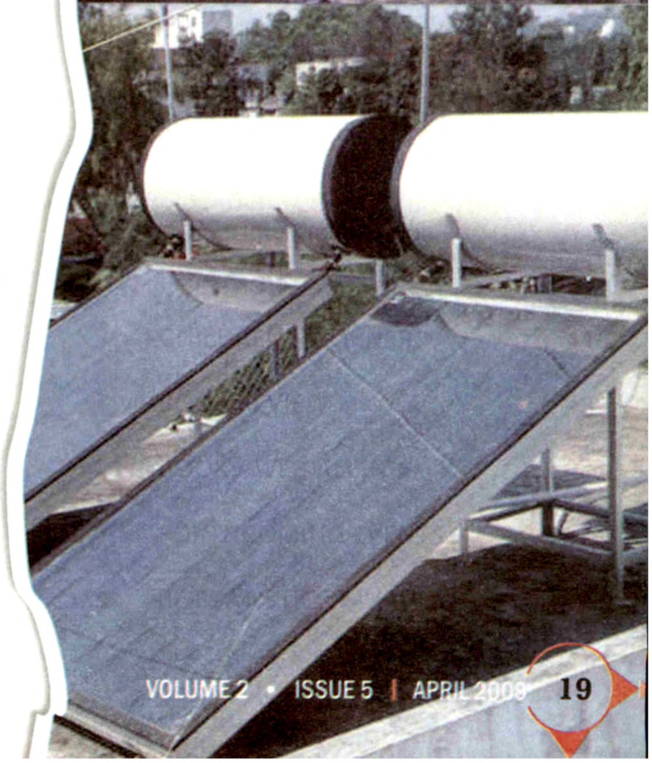
Policy intervention

MEDA has been engaged in the facilitation of many path-breaking policies through active interactions with the state government, regulatory body, and the central government. One of the major responsibilities of MEDA is to evaluate the ongoing programmes and interact with all the stakeholders for evolution of the policy regime. Some of the major policy initiatives taken include the following.

Renewable purchase specification

The Electricity Act, 2003, has clearly given mandate to state electricity regulatory commissions to provide preferential treatment to renewable energy as indicated in the following clause: "86 (e). The state commission shall discharge the following functions: 'promote cogeneration and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with grid and sale of electricity for any





person, and also specify, for purchase of electricity from such sources, a percentage of total consumption of electricity in the area of distribution licensee'.

The MERC (Maharashtra Electricity Regulatory Commission) is one of the leading state commissions in the country to have taken positive steps for operationalizing the above provisions. The timely announcement of tariff for renewable energy technologies, competitive renewable energy tariff structure aimed at the development of such technologies, and other pronouncements regarding green energy by the MERC have led to phenomenal expansion of this sector in a short time frame. These were the crucial interventions by the by the commission in this sector. The added advantage is the improvement in rural lifestyle with the development of local infrastructure and health care centres.

Initiated by the petition filed by MEDA to implement RPS in the state, the MERC has issued an order namely 'Long Term Development of Renewable Energy Sources and Associated Regulatory (RPS) Framework' on 16 August 2006 as a long-term solution. The MERC is the first commission in the country to start the concept of RPS. The new RPS regime has created wide awareness among all stakeholders and therefore, they are now employing all efforts to procure renewable energy. Useful negotiations for renewable energy procurement among renewable energy generators, distribution licensees, grid-synchronized captive users/open access users, promoters, and developers are creating a healthy market for renewable energy.

This will ultimately result in a large-scale increase in renewable energy volume and in the longer run in reduction of renewable energy cost. Some of the salient features of the said order are highlighted below.

- Applicability: distribution licensees, open access consumers, and captive consumers
- RPS percentage: every 'eligible person' shall procure electricity generated from 'eligible renewable energy sources' at the minimum percentages mentioned herein below during the respective financial year.
- Enforcement/penalty: the eligible persons will have to comply with their RPS obligations. Each eligible person in non-compliance with the order is liable to pay to the agency (that is, MEDA) at the rate of Rs 5/kWh of shortfall in 2007/08, Rs 6/kWh of shortfall in 2008/09, and Rs 7/kWh of shortfall for 2009/10. During first year of RPS implementation, that is, 2006/07, there shall not be any charge towards non-compliance.

Financial year	Renewable purchase specifications (RPS)
2006/07	3%
2007/08	4%
2008/09	5%
2009/10	6%

MLA funds for non-conventional energy

The Government of Maharashtra has passed government resolution dated 2 February 2007 for procurement of non-conventional energy devices using local MLA funds. The salient features of this resolution are as below.

- The funds will be made available as per the need of MLA, to promote the use of non-conventional energy at grass-roots levels in the areas of municipal corporation, municipal council, and gram panchayat as well as in the Brihan Mumbai area.
- The concerned gram panchayat, municipal council, zila parishad or municipal corporation will be responsible for getting the work done as per its requirements.
- The operation and maintenance cost of non-conventional devices have to be borne by the local bodies and will not be covered under this scheme.
- The use of these devices is restricted to general/common use only under which local institutes, hospitals, schools, gardens, streets, and government buildings, will be considered.

- Non-conventional devices implemented under the technical guidance of MEDA.
- The concerned district collector shall be authorized to accord administrative approval.
- The code of conduct issued by the Election Commission from time to time shall be taken care of while implementing this scheme.

Inclusion of renewable energy in syllabus

As a follow-up action on the 'Comprehensive Policy on Renewable Energy' announced by the state government last year and in line with Clause 23 of this policy, the Maharashtra State Secondary and Higher Secondary Education Board, Pune have included the matter regarding non-conventional energy sources in the syllabus of Std IX to Std XII vide its circular no. Ra.Man./Pa.Pu.A.-3/8427 dated 4 October 2006.

Introducing certificate course

As a follow up action on the 'Comprehensive Policy on Renewable Energy' announced by the state government, and line with Clause 24 of the policy, the Maharashtra State Board of Vocational Examinations has introduced the six-month certificate course on renewable energy technologies since 2006/07 vide communication no. ITI-2005/205/05/Viashi-2 dated 19 October 2006.

Other useful decisions announced earlier

Besides the above policy decisions taken this year, there are many useful decisions taken earlier by the Government of Maharashtra and the MERC through office circulars, government resolutions, orders, and notifications.

New policy initiatives by MEDA

The MEDA has submitted draft policies for the approval of the Government of Maharashtra on methodology for land acquisition and leasing the tribal land for wind power projects, bagasse cogeneration, and biofuels. These proposals are under consideration of the government.

Conclusion

MEDA is undertaking many more initiatives to popularize and promote renewable energy sources in Maharashtra and other parts of the country. It hopes that these efforts will go a long way in spreading the message of using renewable energy far and wide.

Article courtesy: Maharashtra Energy Development Agency

Achievements of MEDA at a glance

Area	Cumulative achievement up to 31 March 2008
1 Power generation from renewables	
Wind energy power projects (MW)	1753.785
Small hydro power projects (MW)	211.320
Biomass power projects (MW)	52.00
Bagasse cogeneration (MW)	262.00
Municipal solid waste (MW)	0.00
Industrial waste (MW)	6.125
Total (MW)	2285.23
3 Solar photovoltaic and other standalone systems	
SPV lantern	14 654
SPV streetlight	5284
SPV domestic light	2701
Wind aerogenerator/wind solar hybrid system	102 (510.50)
SPV education kit	57
SPV pumps	228
Solar fencing	30
SPV crop sprayer	179
Battery charger	310
Water pumping windmill	234
3 Solar thermal systems	
Solar cooker	47 937
Parabolic solar cooker (SK-14)	830
Solar concentrating technology demonstration project	3
Solar steam cooking systems	7
Solar water heating systems (lakh litres per day)	95.02
Solar desalination system (LPD)	954
5 Biogas programme	
Community biogas plants	72
Institutional biogas plants	35
Night soil biogas plants	352
6 Biomass programme	
Improved crematoria	986
Improved chulha	432 177
Biomass gasifier thermal application	312
9 District level energy parks	**39**
10 Villages electrified	**251**

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BRINGING LIGHT TO RURAL INDIA

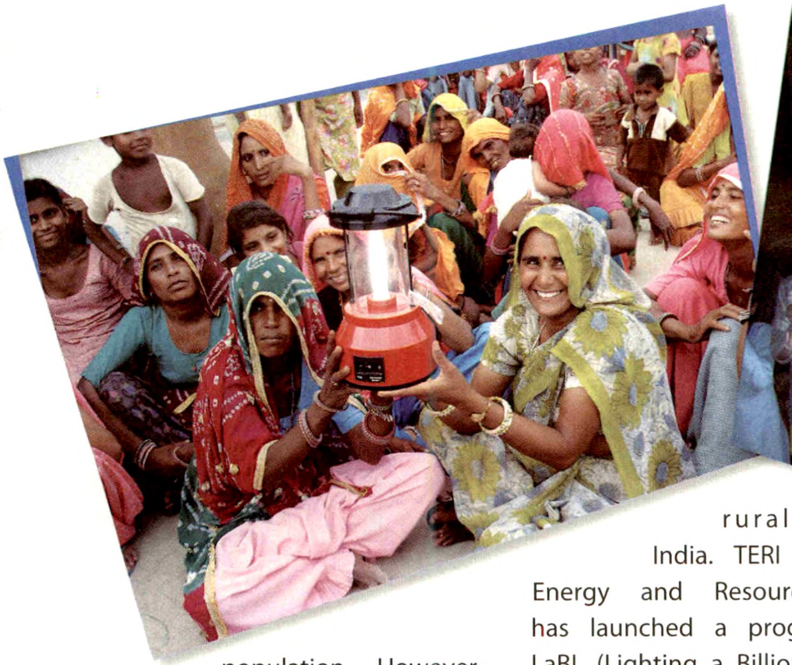
GREENATHON

INDIA'S FIRST 24-HOUR TELETHON FOR THE ENVIRONMENT

AMBIKA SHANKAR, EDITOR, TERI PRESS <AMBIKA@TERI.RES.IN>

Suddenly the environment is everywhere. Of course, it always was but we seem to have noticed it only recently. Not so long ago we were happily ignorant of the trail of destruction in our wake. We polluted with gay abandon. We wasted gleefully. We mined, chopped, and plundered enthusiastically. Then, from our plastic-wrapped bubble of carbon emissions, we looked proudly into the future. The future looked back at us. It didn't look happy. Sadly, we cannot reverse the damage now. We cannot close the hole in the ozone layer and we cannot reanimate the dodos. But there is some light, admittedly dim and probably running on solar energy, at the end of this long, dark tunnel. We cannot renew, but we can recycle. We can reduce pollution and conserve energy.

As dusk slowly lapses into night, it is time for millions to call it a day. For, before the night falls, farmers with their cattle have to be at home, children have to finish studies, and housewives have to finish the household chores, as life comes to a standstill once it is dark. India is gasping for energy—and mind you there are 76 million rural households that are yet to switch on their first light bulb. By 2030, the Planning Commission estimates that India will need to generate at least 700 000 MW (megawatt) of additional power to meet the demands of its expanding economy and growing

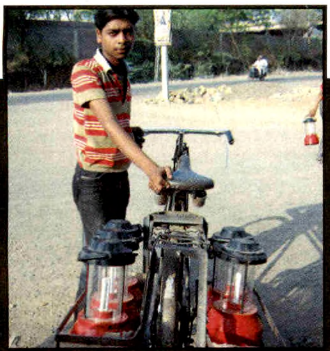


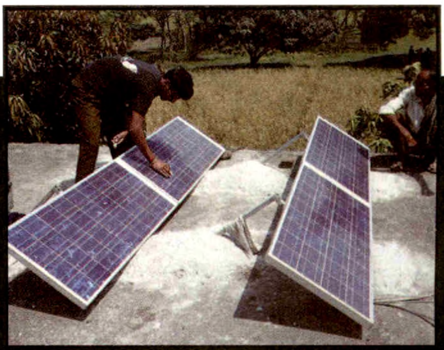
population. However, generating power will not be the end of the story. It has to come from cleaner sources. India receives about 5000 trillion kWh (kilowatt-hour) equivalent of energy per year through solar radiation. Just one per cent of the country's land area can meet its entire electricity requirements till 2030. In 2007, solar energy production in India was 80 MWp (megawatt peak) power, a mere 1.7% of the world total of 4700 MWp. Despite a fairly strong start, India's solar energy movement failed to gather pace. But now with increasing costs of oil and the threat of climate change, the buzz is back.

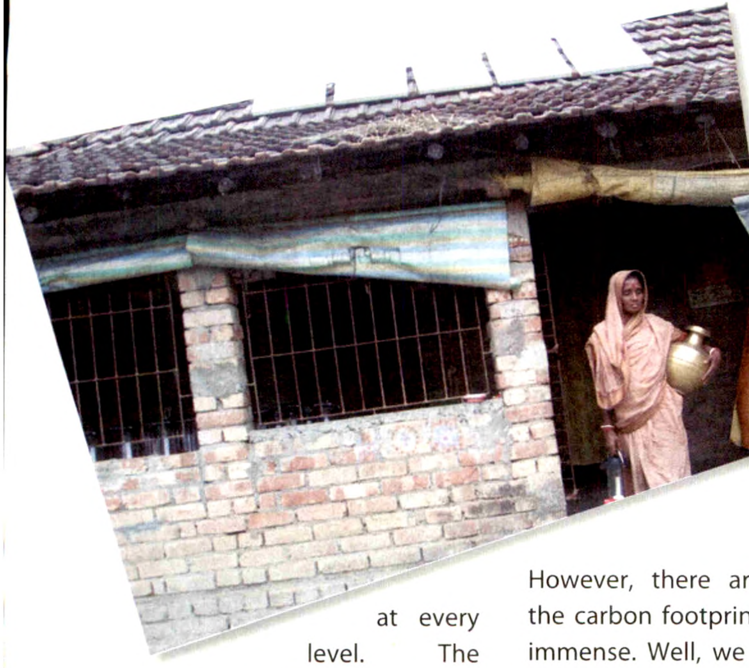
A revolutionary change is required in the field of renewable energy generation, which would bring substantial benefits to some of the poorest citizens living in rural India. TERI (The Energy and Resources Institute) has launched a programme called LaBL (Lighting a Billion Lives), which addresses the sad situation of 1.6 billion people globally who have no or normal access to electricity. The campaign is spearheaded by Dr R K Pachauri, Director General, TERI. Unfortunately, 25% of these – about 400 million – live in India. Yet, this problem can be addressed and solved, if required, through provision of solar lanterns.

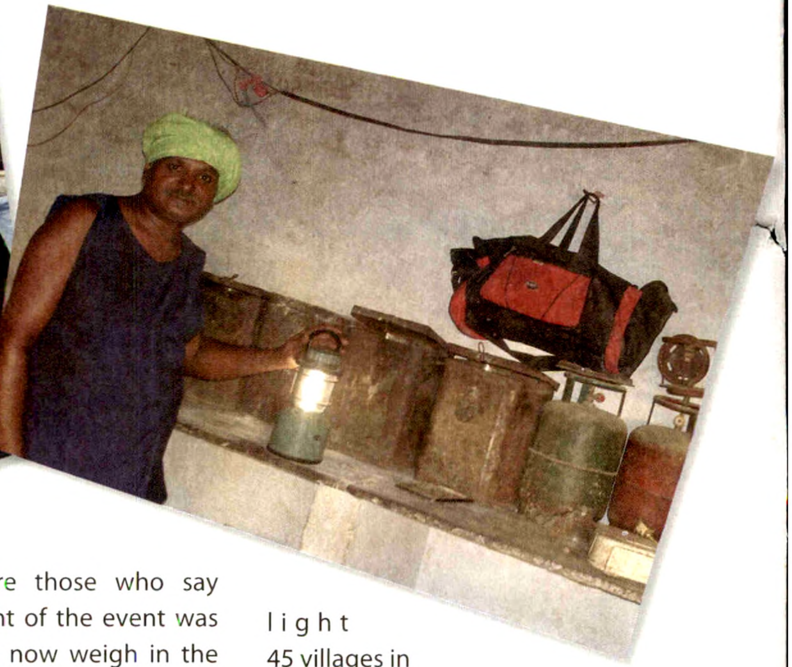
Celebrities are increasingly coming forward to voice their opinion on environmental problems and do their bit for the cause. Taking forward its 'Open Up Tomorrow, Today' campaign to save our planet, NDTV supported by Toyota, telecast first of its kind 24-hour non-stop programme 'The Greenathon', urging Indian citizens to take a pledge towards a greener tomorrow. The NDTV-Toyota Greenathon saw a plethora of stars performing for the environment and advocating the cause of going green. The well-thought-out television extravaganza saw these stars backing NDTV's efforts to raise money for TERI's LaBL campaign and adopting villages themselves as also encouraging people to do the same. For those who take the light in their homes for granted, the Greenathon was certainly an eye-opener into how many people still don't have that one speck of light in their homes.

Spearheading the Bollywood bandwagon was Preity Zinta, the bubbly, dimpled actor who is also the NDTV Greenathon brand ambassador. She felt that the government needs to be pushed. She said Indians are good people but what is needed is education









at every level. The Greenathon started across the NDTV network on 7 February 2009 at 7 pm and ended at 7 pm on 8 February 2009. The telethon was even extended by an hour on request from Dr Prannoy Roy, President, NDTV; and Dr R K Pachauri. There was overwhelming response to the whole event from the entire world.

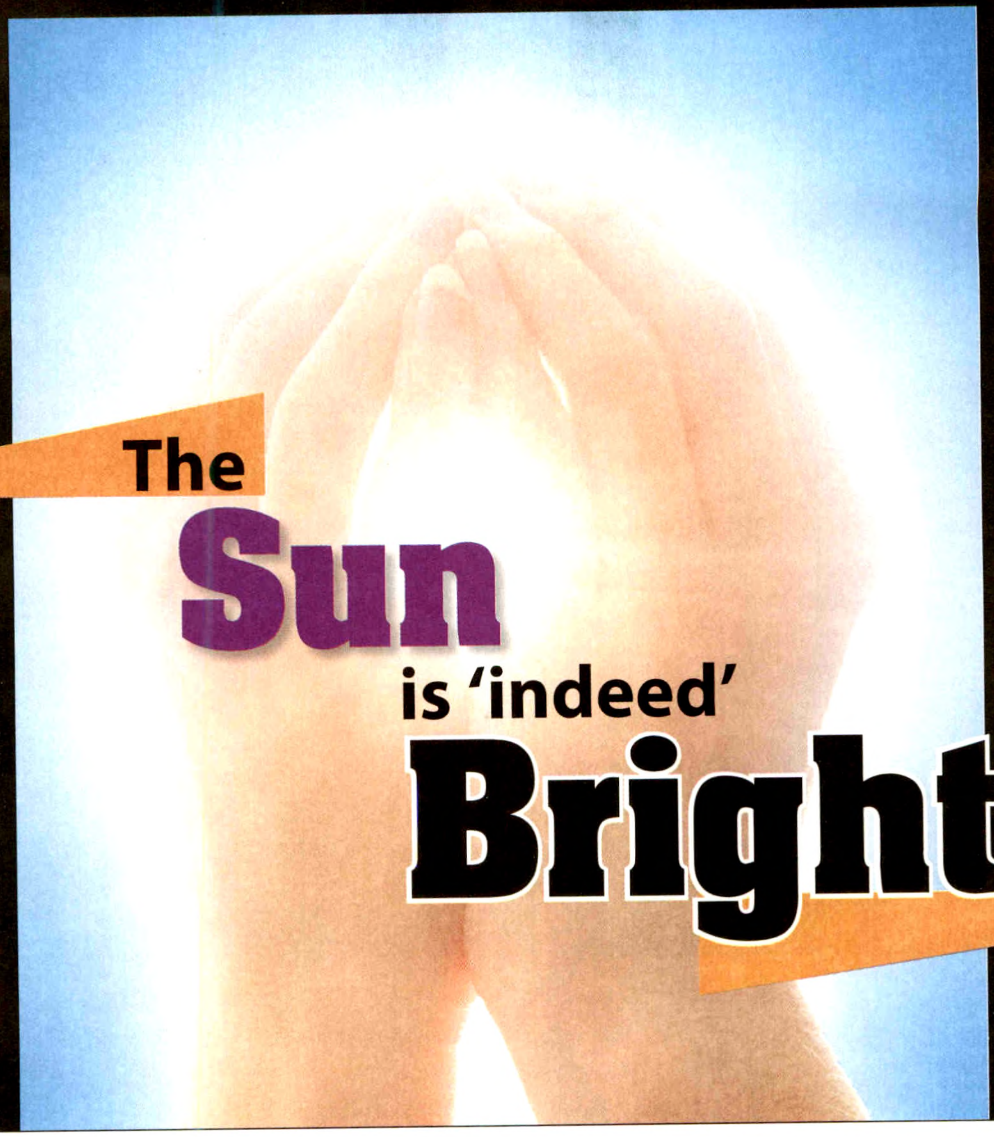
Giving their support to the cause, cellphone giant Nokia adopted three villages in the tribal state of Jharkhand—places that have only seen the natural light of the sun. Dr R K Pachauri, in his closing remarks said, 'This is just the beginning of a long pathway to sustainable deve-lopment'.

NDTV's Greenathon was a raging success in terms of raising money for TERI's LaBL campaign as well as creating awareness about the environment. However, there are those who say the carbon footprint of the event was immense. Well, we now weigh in the pros and the cons. The event was grand but not grander than the aim of saving the planet. So has all the sweat and blood, the muse and the music paid off? Was the cost of emissions to host an extravagant gala worth the impact for a greener future? The facts are all before us. The Greenathon helped in raising funds for the LaBL initiative, which aims to provide solar lanterns to villages that have never seen electricity.

About Rs 2 crore 40 lakh was pledged in just 24 hours! Thousands of Internet users donated online to replace the kerosene and paraffin lanterns with solar lighting in the villages. While cleaning of Yamuna and beaches in Mumbai went on simultaneously, celebrities joined in to spread awareness and gave green tips on living. In 24 hours, participants committed donation to light 45 villages in the poorest of regions. Schools across the country kick-started their own initiatives taking lead from Greenathon. Many schools in Orissa, Bangalore, and Delhi made paper bags. Schools in Pondicherry held Quizathons on environment. Facebook and YouTube created fan groups committed to green initiatives. In short, 24 hours of Greenathon was perhaps a first day towards a much greener tomorrow.

At the end of each day, when we go back to our soft beds in the comfort of our homes, on the other side of the town, lies another bed in a village, in a place called home. Sleep comes without an effort, overshadowing the unspoken dreams of those 'few others' who await another morning that would bring light and hope into their lives—and the LaBL is a step towards that direction.

The Sun is 'indeed' Bright



PROF. ASHOK PARTHASARATHI*

SPV (solar photovoltaics) offer tremendous growth potential to a country like ours. Barack Obama has announced a programme to create five million new jobs by investing $150 billion over the next 10 years, to catalyse private efforts to build a clean energy future. Where does India stand in this field? As in so many areas of national endeavour, it was Nehru who was the pioneer protagonist of solar energy. Indira Gandhi gave a big push in the 1970s and 1980s, and Narasimha Rao in the 1990s. R&D (research and development) and prototype development on solar electricity generating systems (called solar photovoltaics, or SPV for short) had started at the NPL (National Physical Laboratory) as far back as 1955, at Nehru's instance. Small SPV lighting systems were developed and field proven, as were solar cookers. However, solar energy did not catch on till around 1975 because cost-effective materials and technologies for terrestrial applications did not then exist anywhere in the world. Till 1973, SPV power sources were only used to power earth satellites.

It was the first 'oil shock' of 1973 that brought solar cells to earth! The early R&D and prototype development was undertaken by major international US oil companies — Arco Solar & Exxon

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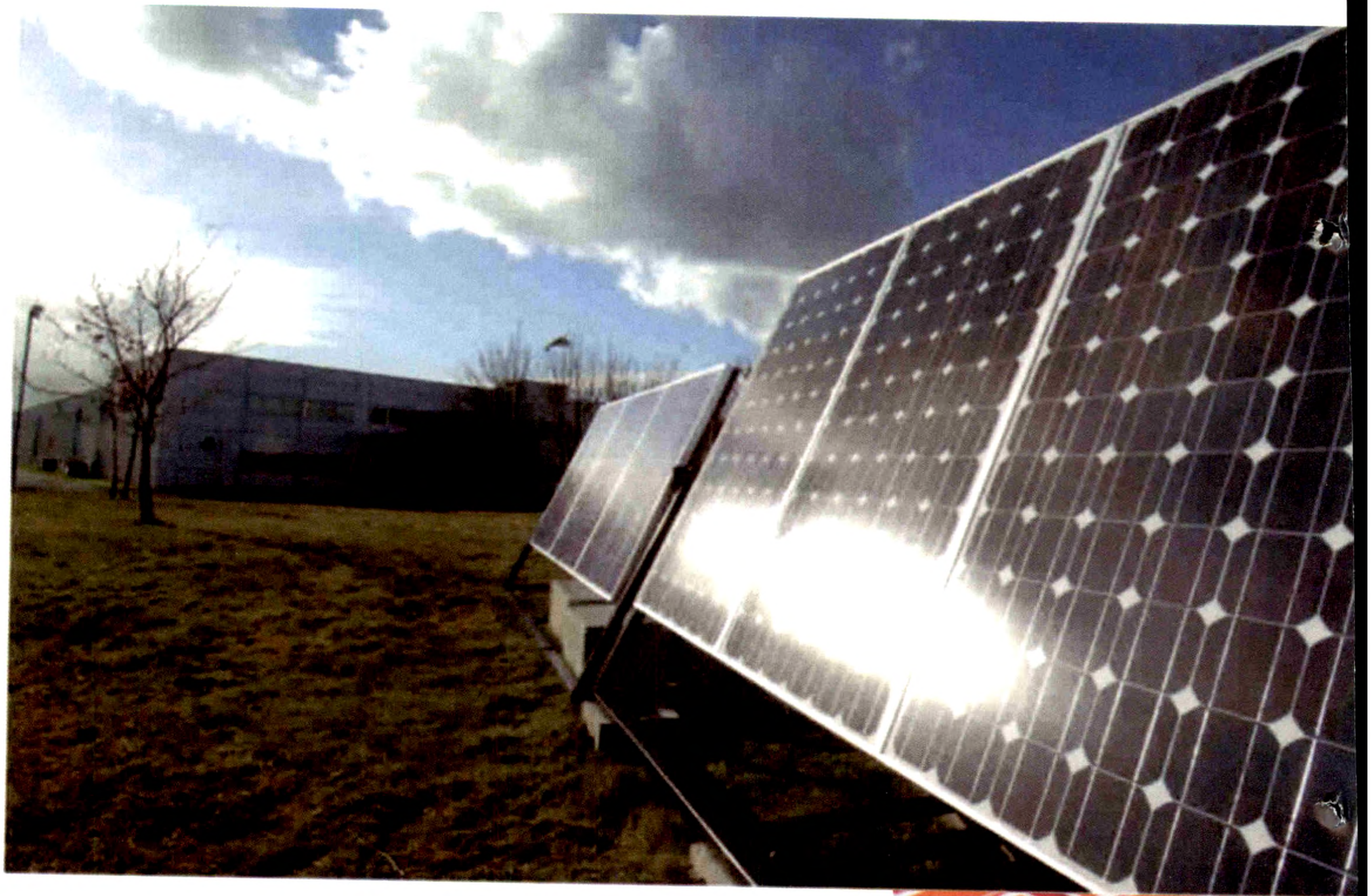
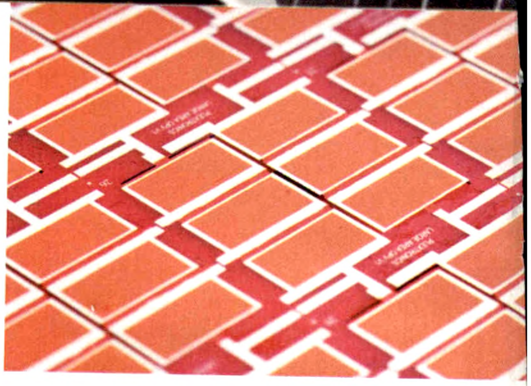
*The writer is former Science Adviser to late Prime Minister Indira Gandhi and former Secretary of various scientific departments of the Government of India.



Solar – with massive funding by the US government. Thanks to a major initiative by Indira Gandhi, an SPV R&D programme was also nucleated in our public sector company, CEL (Central Electronics Ltd), as early as 1976—just three–four years after Arco Solar. Over the last 30 years, we have undertaken a sustained scientific, technological, industrial, commercial, and governmental effort to promote and build up SPV applications, industry and R&D. Consequently, we now have a large and diversified SPV industry consisting of 10 fully vertically integrated SPV manufacturers making solar cells, solar panels, and complete SPV systems, and about 50 assemblers of various kinds. Between them these companies make and supply about 200 MW per year of 30 different types of SPV systems in three categories: rural, remote-area, and industrial. We also have at least six centres of R&D in government laboratories and IITs.

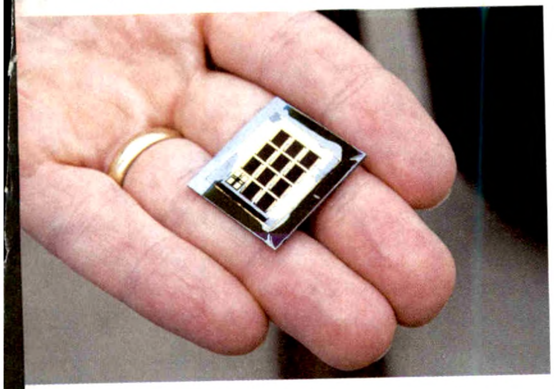
CEL was the world's first – in 1985 – to design, develop, engineer, and manufacture SPV power systems for powering a large amount of electronics on the offshore oil well-head platforms of ONGC in Bombay High. Today, some 60 such platforms have been 'solarised' by CEL. The world's second manufacturer of such SPV systems was BP Solar of the UK in the Persian Gulf, but only in 1990. CEL has done likewise for special-tech, ultra lightweight SPV man-pack battery chargers for wireless communication sets for our jawans all over the country, but particularly in Siachen where they have to work continuously on a 'fail-safe basis' at temperatures as low as minus 40 °C and in the Thar desert where they have to do likewise at (plus) 55 °C. Over the years, CEL has supplied about 14 000 such solar chargers to our army and also selectively exported them. There is no other company making such chargers anywhere in the world and they have also been internationally patented.



CEL has also exported many types of its SPV systems to some dozen other developing countries. It has also exported its proprietary SPV technology and set up manufacturing plants in Syria, Sudan, and Kenya in competition with Western SPV companies and made substantial profits on those projects.

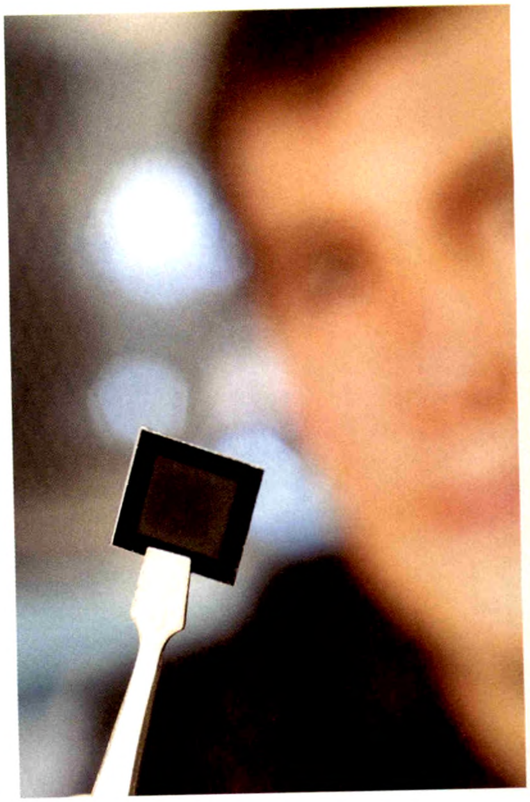
Taken as a whole, we are among the top five countries in SPV energy and number one in many areas. At 2.8 million as of 31 March 2008, the total number of stand-alone SPV systems of the 30 different types our companies have manufactured, installed, commissioned, and operationalized is by far the largest number of SPV systems set up by and installed in any one country—and almost all based on Indian technology. Most of these systems are installed and operating in a developing country's rural or remote areas. This uniquely requires that they be reliable and rugged enough from design to commissioning to operate on a 'fit and forget' basis.

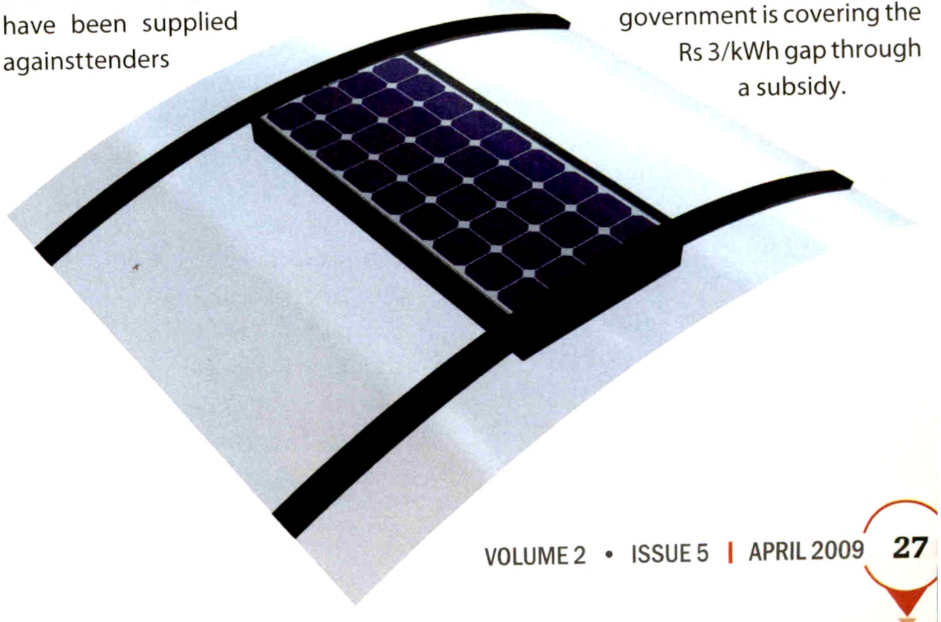
Apart from such stand-alone SPV power sources meant for remote area rural and industrial applications, the MNES/MNRE programme has, over the last decade, involved a large number of public grid and local grid based SPV power plants having capacities ranging from 5 kW to 200 kW, for a diverse range of users—from the two buildings of the M S Swaminathan Research Foundation at Chennai where there is no conventional grid supply at all, to the main building of the R&D Engineers of DRDO at Pune, to the Maharshi Centre in Nagpur.



Several pilot projects have also been undertaken by our SPV manufacturers of specially designed, grid-connected 100 kW power plants at the front end of conventional grids for peak shaving and at the tail end for voltage stabilization. They are working well and generating valuable data for the design of future systems. The use of SPV for such applications is in its infancy even in the industrialized countries.

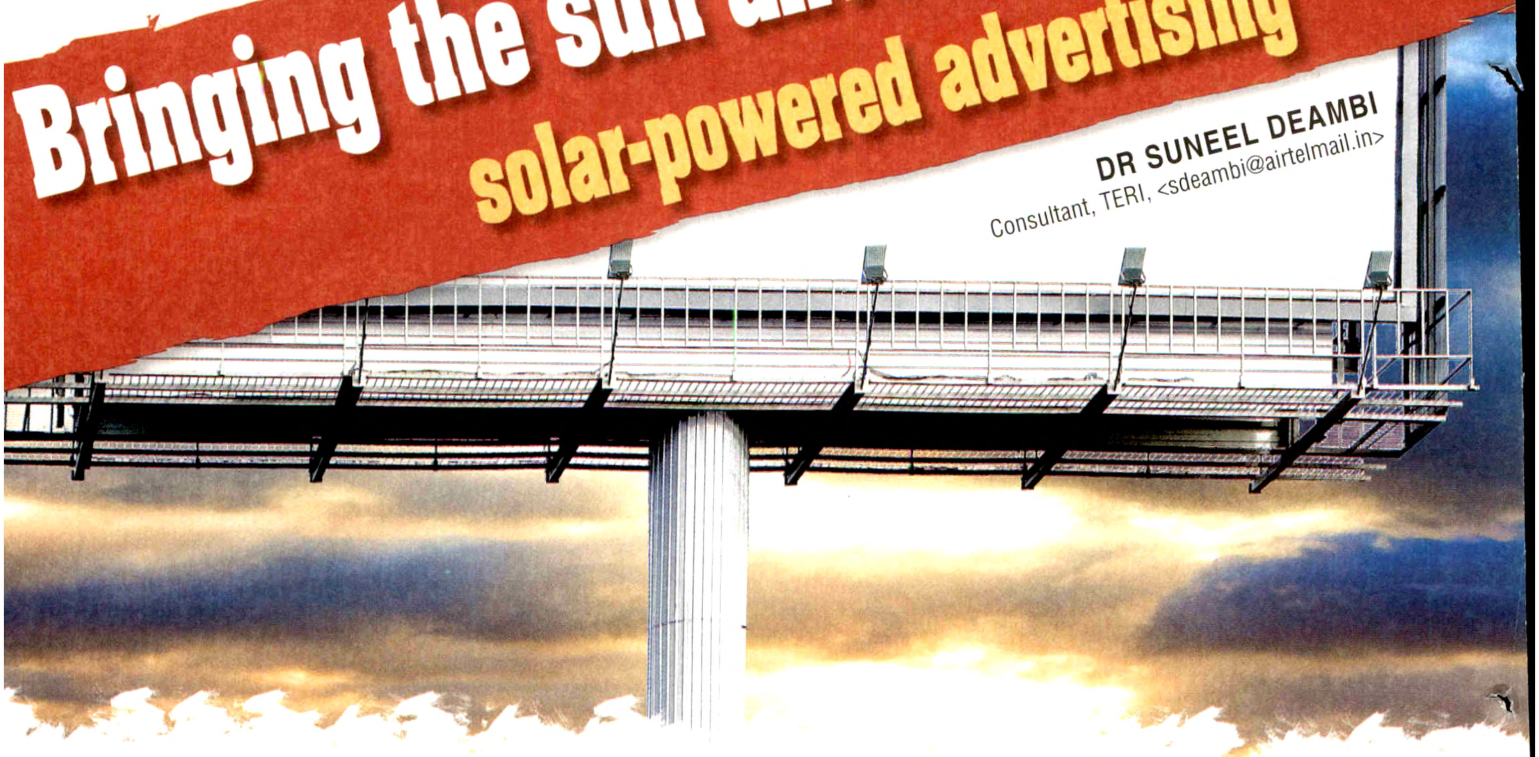
A major success story in the use of SPV power on a local grid is that of Sagar Island in the Sunderbans in West Bengal. The Mission, 'Sagar Island — Solar Island', was inaugurated in December 1996. It consisted of providing high-quality, 50-cycle 220-volt solar-derived electricity for home and street lighting and solar pumps to all the 12 000 homes on the island through a local grid, and powering a large fish freezing plant through a wind–SPV hybrid power plant. With a steady and sustained programme of adding modules from 20 kW to 120 kW, a solar power-generating capacity of 500 KW was operationalized by end-2000; another 500 kW has since been set up. The SPV panels and the complex electronic power conditioning systems for all the 25 kW power modules have been supplied againsttenders floated by the WBREDA (West Bengal Renewable Energy Development Agency) by six of our major SPV manufacturers, based entirely on local know-how, while the overall system design and engineering was done by WBREDA. Sagar is the only totally SPV island in the world. The cost of the generated power is Rs 10/kWh, but the villagers on Sagar, knowing fully well that they will never get electricity by any other means, are paying Rs 7/kWh while the West Bengal government is covering the Rs 3/kWh gap through a subsidy.





Bringing the sun alive at night
solar-powered advertising

DR SUNEEL DEAMBI
Consultant, TERI, <sdeambi@airtelmail.in>



Introduction

Are you mistaken at the thought of the sun making a brief appearance at night nowadays? Certainly not since the sun happens to be the most powerful entity breathing life into anything and everything. A quick detour along the countryside brings alive the role of sun at night. The rural homes cheer about the presence of solar light, the young student studies by the side of a solar lantern, and an artistic hand somewhere weaves dreams of change. That is not all. The use of solar energy is now moving into new frontiers, some as varied as illuminating the billboards. Perhaps the sun is becoming brighter as the day progresses more so in the rural landscapes and lately within the urban ambiences too. The moot question that remains is whether there is a compulsive need to use solar energy for urban uses like advertising? This article delves deep into a few such reasons finally leaving the choice of use with the end-user itself.

It has been well said that take business to people rather than taking people to the business. There is nothing wrong with this proclamation excepting the fact that power is playing hide and seek with those who try to enforce this maxim. To remedy this situation, the generators are there as a standby option, but offend the sensibilities of quite a few for the following few reasons mainly.

- Encroach on the limited space available (within the commercial complexes like office buildings, shopping malls, and so on)
- Lead to noise and smoke pollution (not all the generators work in a silent mode)
- Use the vital import dependent commodity (that is, outflow of precious foreign exchange)

It would not be out of place to mention here that the sun has been advertised in the open for many years now. The most well known example is that of solar street lighting systems in the sense that it stood out when everything else failed on the road. However, it cannot be taken as a concrete example of solar advertising. Before we delve deeper into issue, let us try to mention a few compelling reasons in support of using solar powered advertising. These mainly include the following few.

- Conventional power is not available in a full measure for meeting the basic needs.
- Conventional power used for advertising in a large measure drains the already limited supply of power.

- There may be a public appreciation to look at such glowing signages, but a section of public opinion is surely against use of grid power for such purposes.
- Solar power is a clean source of power and works in a silent mode without slicing any share of the power that may have been intended for any community use.
- Solar-powered advertising can well be taken care of by the elite corporate entities, keeping in view its high initial capital cost.
- Solar offers immense environmental gain as against the conventional power.

There is nothing new per se in the concept having been put into action more than a decade back. However, what is certainly new is a renewed liking and thrust to make it happen on a more visible scale. Let us analyse some of the most tried out solar mediums of advertising here.

Solar signboards

These systems akin to a normal solar street lighting system were initially put up at selective few places. For example, one could see an array of such sunlit boards along the Lady Shriram College stretch in New Delhi. These worked well for some time before fading into memory not necessarily for want of any repairs and so on.

Solar bus shelters

The garden city of Bangalore in particular experimented with the solar power lit bus shelters. In fact, a still role was conceived for such locations.

Solar on-line news

A private news channel came up with a bright idea of displaying the news as it unfolds on the solar-operated panels close to the busy traffic intersections. This proved to be of a good news value mixing both the ancient and modern source of energy together. There are still quite a few such systems installed in places like Delhi and Noida in the NCR region.

Solar traffic kiosks

Manning traffic on the congested roads of a metropolis like Delhi always poses its own difficulty. The traffic personnel, often very few in numbers, struggle to direct such traffic. Solar kiosks put up on a few intersections were a true delight to watch for some time at least. One could for example feel satisfied watching a traffic policeman guiding traffic through solar-operated public address systems. The kiosk offered succour to the occupant by way of a solar run light and fan. However, what one saw after a while was the open vulnerability of such systems put up by a reputed south-based solar manufacturer. These were vandalized though standing in a full public view by perhaps those who liked to bask in the winter sun, but unaware of its great roadworthy promise.

Solar bus route panels

An upcoming company in New Delhi tried to sell the concept of illuminating the bus route number plates fixed at numerous bus shelters in the capital city. The sheer logic was that a large number of commuters fails to read the bus route numbers when more often than not, streetlights fail at night. A few such systems were put up on a trial basis to be dispensed with after a very limited period of demonstrated use.

A typical conventional advertising hoarding

Large-sized hoardings are in full display across big cities and towns in the country (see Table 1).

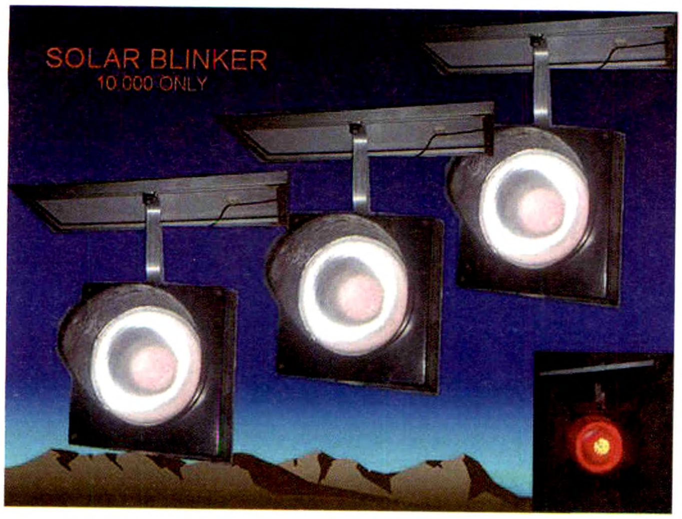
A possible technical option is to bring in solar power to take care of small hoardings in the first instance. These may well be operated during the peak hours from 6 pm to 10 pm. To meet this objective, it may well suffice to install a 1-kWp solar power system.

Case specifics

Let us take the example of a conventional advertising hoarding publicizing some product or service. Each such hoarding uses at least a couple of halogen lamps of 460 watts each. This brings its daily energy consumption to nearly 1 kilowatt. Let us assume that it runs for just 5 hours a day meaning thereby an

Table 1 Description of various hoardings

Lamp Type	High-intensity halogen lamps
Average number of lamps used	4–12 lamps
Average hours of operation	10–12 hours
Average energy consumption	Few kilowatts
Likely benefit of avoided power use	May well be used to light up small towns and villages still reeling in darkness especially between 6 pm and 10 pm every night.



average power consumption of 5 units per day. Thus, a single hoarding is going to consume about 1825 units in a year and this number multiplied by a fairly large number of hoardings in a city like Mumbai for example takes the power consumption to new heights at least not in that sense of connotation really.

Is solar power the real alternative?

The figures projected above point to an alarming need for saving such misuse of power for other more productive purposes. Even if any viable alternative like solar power could lead to savings of just about 10% or so, it could well spell immense overall gains in the real sense. Few most distinct advantages that solar mode of advertising could offer are as under.

- Substitute high power lamps with minimal power LED lamps
- Offer automatic timer-based operation, which sense the available sunlight and accordingly switch on/off the system
- These do not produce heat and thus have no carbon emissions associated.
- Can be used practically with any type of hoarding
- Need minimal maintenance on a daily basis

The ministry outlook

The MNRE (Ministry of New and Renewable Energy) has embarked on an ambitious plan to enhance the visibility of solar power in the urban areas in terms of supporting the demonstration of various end-use applications like solar advertising. According to ministry sources, the street lighting and outdoor advertisement panels in the country amounted to a power consumption of about 20 000 MW. The intention is to make state governments see sense of purpose in moving towards the use of solar power for such applications. In fact, the honourable minister himself has already undertaken wide-ranging deliberations with the state governments of Andhra Pradesh, West Bengal, Maharashtra, and Karnataka.

The response to this proposal has been by and large positive with even hope of advertisers being ordered to experiment with the use of solar power instead of conventional power. If implemented, it could signal a big change in the urban landscape, which is struggling hard not only to meet its power needs, but also to keep it clean. In fact, the MERC (Maharashtra Electricity Regulatory Commission) has already banned the use of conventional neon signs that illuminated hoardings and floodlights in the city of Mumbai between 5 pm and 11 pm. The obvious choice is to use solar power at least for a small number of such hoardings to begin with.

Supporting the initiative

The concerned ministry is finally supporting the use of illuminated hoardings (see Table 2).

SPV systems have been widely demonstrated in the rural landscapes with a fairly good degree of success with each year of experience gained. The time has come to replicate the success at least in a small measure within a chosen few cities in the country. MNRE has just announced that Nagpur in the state of Maharashtra is going to be the first solar city by 2012 followed up by a well-designed plan to build 60 more such cities. The intention is to have at least one city in each state to a maximum of five cities in a state during the ongoing Five-year Plan period (that is, 2007–12). The distinct reasons for doing so are the following few.

- Minimize dependence on the use of fossil fuels and expensive oil and gas
- Encourage the use of renewable energy
- Generate all round awareness for stimulating the interest of potential buyers of solar systems for example

Table 2 Ministry's efforts on the initiative

PV module capacity	Up to 1 kWp
Threshold area under illumination	2 square metre
Daily hours of operation	About 6 hours
Grant available from the ministry (that is, MNRE)	50% of the total cost or Rs 15 000/100 Wp, whichever is less
Total number of hoardings to be supported per year	Maximum of 500 (limited to just 20 hoardings per corporation)
Implementing agency	Municipal corporations

A variety of systems are going to be introduced in the solar cities coinciding with a larger aim of generating requisite awareness amongst the public at large. These mainly include the following.

- Solar hoardings
- Street lights
- Garden lights
- Traffic lights
- Solar water heaters
- Energy-efficient green buildings

Quite clearly, the solar way of advertising may receive the much-needed fillip so as to be increasingly visible.

It is quite logical to assume that those using solar power daily for their bare minimum lighting needs (say for example in the rural areas) are more aware of the immense power of the sun and thereby the solar technology. However, that is not exactly true with the urban dwellers. There are several key reasons for this.

- Major chunk of the population relies on grid power
- Solar systems are switched on mainly at night, when it's the time to rush for home
- More often that not, the solar use of the system is not properly and clearly highlighted (solar module is not always instantly recognized by a majority as being a power generating device)

However, there is more than what meets the eye on road. The advertisement panels seem to blink as time advances for whatever reasons. Amongst the few possible reasons could be the following.

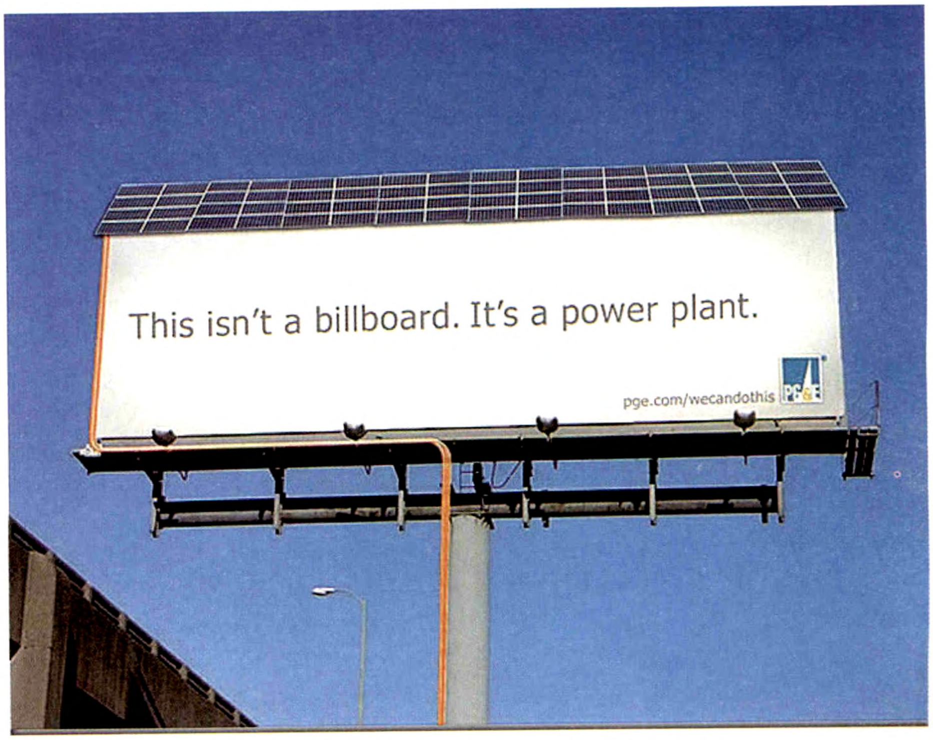
- The system is mostly installed on roads with a high traffic density. It leads to accumulation of atmospheric impurities like dust on the surface of panels.
- The panels go without regular cleaning for many days at a stretch and thus lead to low power generation and hence less storage capacity of the associated battery.
- The battery needs to be topped up at regular intervals, even if it is a low maintenance tubular plate battery partly due to being positioned in that kind of ambience.

In view of above, the roadside perception of the general viewers does not emerge very favourably.

The need for solar-powered advertising

Youth is fun (pun unintended) makes a very good target segment for use of solar advertising. Colleges in particular can be ideal spots to popularize such new generation systems. A few solar-powered advertising companies, though in a limited manner, have been able to display the messages of corporate houses in the premises of both educational and professional institutions. However, it may not be economically viable to use solar power for advertising anywhere and everywhere. Nonetheless, one could think of few ideal spots for solar power use as mentioned below.

- Eco-tourism cottages, where visitors could get across the message of using solar power crisp and clear They may also not be reluctant to part with some part of their earning for such a cause.
- Pathways of famous mall roads be it Shimla, Mussoorie, or any such place in the country The product appeal in those type of serene surroundings may be a thing to watch, when the message to use solar power is loud and clear.
- Hotels, motels, and dhabas, which act as stop points during a long outstation journey on the highways offer a definite scope for embracing solar advertising.
- All major places of pilgrimage, where people throng in lakhs could be given a serving of solar advertising. Quite often, such devotees queue up for long hours and thus could imbibe and admire the concept of sun being there at night as well—be it flashing of token numbers on the



panels or announcements displayed.

- Majority of commercial complexes, where roof space is available and could be utilized for the purpose of advertising.
- Popular heritage sites and monuments, and even parks and gardens, could find solace with solar power messaging.

The moot question is whether solar power can lift up the spirit of people while they go out. For example, why do we see so little of it even in this age of high environmental consciousness? There seem to be a few compelling reasons to do that, which may be mentioned as under.

- A conventional power hookup still seems to be an easy way out.
- Not all locations are well suited for using solar power.
- Solar system vulnerability in the outdoor environment is still an issue to reckon with.
- The high initial capital cost consideration does not seem to fade away especially when it comes to having large number of sun-powered hoardings.

The way forward

We now have a glaring example of how solar power is gradually replacing the use of diesel generators for a critical application like running of base transmitter stations for mobile telephony. Till just recently, such an option was being ruled out on various grounds—some flimsy too. The same type of situation could be witnessed for a variety of the following few considerations.

- Someone has so well said that if people cannot come to business, take business to the people. This clearly means that advertising is going to stay here for long. So, it does need power all the time.
- There is an increasing gap between the demand and supply of conventional power. It surely leaves a window of opportunity for solar power to peep in.
- The standby mode of power, predominantly the generators especially those being used in a haphazard manner and with little regard to noise and emissions are lately being viewed as high-risk elements too.
- The price of conventional power is moving way up and it may not be long before solar power actually prices itself competitively.
- A section of population, even though still small in number, has developed a certain fervour for eco-friendliness and they would like to view it in all ways possible.
- The issue of climate change is now receiving attention at the highest level and solar power is an in-thing now waiting for a green signal to take it places—a good advertising medium indeed.

It is crystal clear that the sun can come out in the open at night too. There seem to be various niche areas of its presence during those odd hours as well, not to talk of beaming breaking news on panels through the day at busy crossings for example. It is in the fitness of things here to lay bare the expectations from the solar power community, that is, all those who are votaries of this clean source of power.

- Design, develop, and demonstrate truly well performing systems, which will work flawlessly over long periods of time.
- Small is beautiful maxim may well apply in this case, as it is somewhat easy to make someone (even a corporate entity) pay up for solar power use.
- A bigger system is not necessarily the best for quite a few reasons. More often than not, it becomes a huge burden to mobilize resources for replacement of battery bank. Thus, the idea should be to go for small systems mainly.
- The trick of the trade seems to be in garnering support from every possible quarter and not just the corporate sector alone.

Conclusion

The solar way of reaching out to the masses is possible in more ways than one. However, what is certainly needed is to instill confidence in such systems and leave the rest wide open for others to rejoice at.

IMPERATIVE FOR RENEWABLE ENERGY SOURCES

R S RANA, CDA (Army), Meerut*

Introduction

After Independence, India embarked on the road of planned economy and therefore efforts were made for planned growth in different sectors including the power and energy sectors. During the last six decades, India has made significant strides in power generation, energy supply, and technology in the power sector. The current cumulative power generation capacity is more than 147 965 MW as on 31 March 2009 produced from different sources. Fossil fuels namely coal, oil, and gas together play a dominant role in power generation, which accounts for about 64.6%; the share of hydropower is 24.7%, share of renewables (including small hydro) is 7.7%, and the contribution of nuclear power is 2.9%.

However, the challenges in the 21st century in the energy sector will be formidable considering requirements of the growing economy and the energy needs of the increasing population. India's energy consumption has increased by 25% from 1980 to 2001, basically due to impressive economic growth, ever-increasing population, and the increased income levels of the vast segments of the population. The energy need of India is approximately 2.5 times more than that of the developed countries even though India's total per capita energy consumption is still 531 kgoe, which is still very low compared to world figures of energy consumption and lower than China's per capita consumption of 1090 kgoe.

It is estimated that the energy requirement, in terms of electricity alone would be 800 000 MW by 2030 at a growth rate of 8%–10% per annum. More than 100 000 MW would have to be added in the Tenth and Eleventh Plans up to 2012 to match the increasing demands of the expanding economy and the population. There will also be an increase in the energy demand in remote and inaccessible villages/hamlets for their socio-economic upliftment thereby leading to corresponding removal of poverty and regional imbalances of economic growth. Therefore, it will be a formidable

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*R S Rana was Director (Finance), MNRE, from 1998 to 2003.

challenge for the country to ensure its energy security.

Need for renewables

Due to inherent dangers of the fossil fuel dominated energy security such as geopolitical uncertainties of oil and gas supplies and attendant risks attached to growing oil and gas prices, and with India's dependence on oil imports likely to grow up to 91.6% in 2020, it is imperative for India to reduce its dependence on fossil fuels for meeting its growing energy requirements and energy security. The issues of atmospheric pollution and consequent climate change concerns as a result of massive use of fossil fuels shall also restrict the use of these sources in the future. There is thus, an urgent need to increase the tapping of renewable sources of energy for ensuring energy security of India in a climatically sustained way.

The GHG (greenhouse gas) emissions are primarily caused by the use of fossil fuels, which is resulting in global warming and climate change. According to prevailing scientific view, without a reduction in GHG emission rates, global warming from the build-up of GHGs is likely to lead to substantial and largely irreversible transformation of climate, ecosystems, and coastlines, later in this century. Obviously, the use of fossil fuels in the long run shall be restricted by the concerns of climate change.

Renewable energy sources are available in abundance in India. The major focus on renewable energies particularly solar and wind would do much to reduce India's dependence on fossil fuels, lower its import bill, and also provide a buffer from the vagaries of oil prices. Similarly, the other renewable energy sources such as biomass, small hydro, tidal, and hydrogen have tremendous potential to contribute to the energy needs of the country and gradually replacing the fossil-fuel-based energy supply and demand. These sources are development imperative and the energy of the future. These sources will also increasingly meet the energy requirements of the rural households with regard to their day-to-day requirements of cooking, heating, and motive and commercial activities. In fact, renewable energy applications will also be useful in electrification of unelectrified villages/hamlets. About 25,000 such villages are to be electrified through renewable energy sources by 2012.

However, the national policy on renewable energy and the investors, both domestic and international, is yet to identify the domestic energy sector as a growth area. Conventional energy has a significant edge over renewable energy in terms of investment, promotional policy initiatives, and in-built subsidies. In fact, the need to promote renewable energy in a sustained way is felt only when the global prices of oil and gas are overheated causing inflation and affecting the living standards of the people. By adopting innovative financing mechanism backed by government initiative on promotion of this sector of energy and duly assisted by the emergence of carbon credit market, renewable energy can see a significant growth to meet the grid interactive as well as decentralized energy needs of the country.

FINANCING SOLAR HOME SYSTEMS

Aryavart Gramin Bank shows the way

Uttar Pradesh is one of the poorer states in India. For centuries, people have been subsistence farmers, growing rice, wheat, lentils, and mustard seeds. Some cash crops like sugar cane, potato, and mentha are now also cultivated on a large scale. Buffalos are reared for milk and meat. Over the years, the farms have become smaller as the land is divided between children. Many rural areas of the state have no grid electricity and even where the grid is available there are frequent power cuts. Some shops provide a battery-charging service so that people can run DC lights and small appliances from car batteries.

PV (photovoltaic) SHS (solar-home-systems) can be very effective in providing power for lighting and small appliances. However, in many parts of India, and other developing countries, the main obstacle for rural families who want to have an SHS is finance. Throughout India, there is a well-established network of Regional Rural (Gramin) Banks, which were set up from October 1975, to make banking facilities available in remote rural areas, and to make small loans easily accessible to farmers and other rural people.

The Aryavart Gramin Bank, Lucknow (after amalgamation of three Regional Ruaral Banks namely Avadh, Barabanki, and Farrukhabad sponsored by Bank of India w.e.f. 3 October 2006) caters to six districts of Uttar Pradesh, namly, Lucknow, Barabanki, Farrukhabad, Hardoi, Kannauj, and Unnao covering about 8500 villages. Of these, more than 2500 villages do not have grid power.

Aryavart Gramin Bank has set an example that could be followed by the other banking/finance institutions and they can play a vital role in removing the darkness in the lives of Indian villagers.

With this objective of discharging corporate social responsibility, the bank came up with an innovative idea of financing SHLS (solar home-lighting systems) to its proven customers and devised a scheme.

SHLS were chosen because they carry underlying social, economic, and environmental benefits.

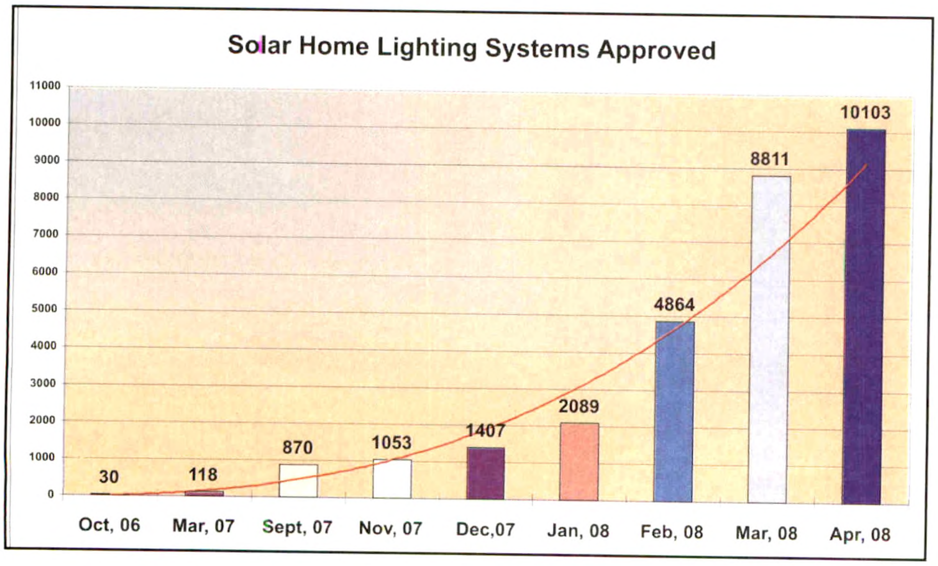
- The system is very simple with low operating and maintenance cost.
- The power generated can be utilized for domestic as well as commercial purposes.
- Method of installation is simple and the unit is easily transportable.
- Cost of installation is a one-time affair and constant supervision is not required. The maintenance charge is also negligible.
- The system is free from noise and air pollution, and other health hazards.
- There is an improvement in the living environment with uninterrupted and sufficient light.
- There is also an increase in income due to availability of light for longer period resulting in extended working hours.

At the time of amalgamation, the bank had financed only 30 SHLS. By October 2007, the number went up to 984. The scheme took off in a big way when the bank started organizing exclusive credit camps for financing SHLS from January 2008 and reached a figure of 8811 SHLS as on 31 March 2008. By the end of first quarter of financial year 2008/09, that is, June 2008, the bank had approved/sanctioned 20 037 SHLS.

The scheme

The scheme offers an excellent opportunity to promote the use of solar lighting. To make the scheme acceptable to, and for the benefit of the common man, the bank thought it prudent to look into the following factors before launching the project.

- The cost of the SHLS should be such that a common borrower is able to afford it because subsidy was not available in the scheme.
- SHLS should be of a reputed company.
- Quality of the SHLS should be indisputable.
- Business facilitators should be engaged to maintain the SHLS.



Understanding with TATA BP Solar

The bank identified TATA BP Solar, which is a joint venture between TATA Power Company Ltd, a pioneer in the power sector in India, and BP Solar, one of the largest solar companies in the world. Their model 'Venus Solar Home Lighting System', being cost effective, was chosen as the product for village homes.

Economics of the solar home lighting systems

The economics of the SHLS was as given in Table 1.

Table 1 Economics of the SHLS

Project cost	Rs 13 520
Amount of finance	Rs 11 000
Down payment	Rs 2520
Equated monthly installment	Rs 245*

(*with interest @ 12% per annum on reducing monthly balance)

A villager presently uses minimum lighting of 2 hours for cooking and up to dinnertime, which requires a minimum of 8 litres of kerosene per month, costing Rs 280 approx. at street price of Rs 35 per litre. Thus, the borrower does not have to bear any extra cost/burden.

For maintaining 100 such systems, the branch managers identify a local youth who is trained by the company/dealer. He is provided with a kit by the company to maintain the system. The bank pays him Rs 10 000 per annum (Rs 500 per month and Rs 4000 in lumpsum if he maintains 100 systems all throughout the year [as reflected by 100% recovery of monthly installments]).

The bank foresaw immense potential to make the project successful in a big way, through the network of its 287 branches (now 290) spread in 6 districts of Uttar Pradesh with a growing customer base. Majority of staff being local, they have excellent rapport with the clientele and can spread the message of social, economic, and environmental benefits of the scheme amongst them. The bank communicated the benefits of the scheme by initiating steps to bring about awareness, organizing camps, and lecture demonstration on the working of the system, and so on.

For its efforts, the bank was awarded the prestigious International Global Green Energy award by Ashden Trust for the year 2008 for pioneering work done by it in financing SHLS and solar power packs. The award was received by the founder Chairman, Aryavart Gramin Bank, from Dr Wangari Maathai, the 2004 Nobel Peace Laureate at a ceremony held in London on 19 June 2008.

Article courtesy:
Aryavart Gramin Bank

Inviting advertisements for Akshay Urja

Akshay Urja is widely circulated to various stakeholders of renewable energy. *Akshay Urja* invites advertisements (in colour) from interested organizations, manufacturers, institutions, etc. The advertisement tariffs are as follows.

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Full Page	25 000

* Avail 25% discount on booking for six issues and 20% discount on booking for three issues

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Lighting up lives in village Saradi

A K TYAGI, CPO, UREDA
G R SINGH, Director, MNRE

If the electricity supply fails even for a day, we feel very uneasy. Imagine a remote village that has never seen electricity and where there is a remote possibility of extending the grid. It means that the villagers will never enjoy watching television; children cannot hope to study at night; and life virtually comes to a standstill after sunset. Saradi is a forest-fringe village situated in Kalsi block of Dehradun District and is about 70 km from the state capital. It is situated on a hilltop at an altitude of 1200 metres above mean sea level. The inhabitants of Saradi village were living in darkness since long. Being situated in a remote location, this village was not covered by the electricity department and the people of the village were living in darkness; their children have not has the opportunity of studying at night; and the old villagers thought that they might never see electricity for their remaining life. Thus, the life in this village was moving at a very slow and dull pace.

The MNRE had sanctioned the Saradi test project in January 2006. The project has been implemented by UBB

(Uttarakhand Biofuel Board), Dehradun and coordinated and monitored by UREDA (Uttarakhand Renewable Energy Development Agency), Dehradun. Before providing electricity in Saradi, the villagers were using kerosene for lighting and other purposes. The UBB constituted a VEC (Village Energy Committee) in the village for helping the implementing agency in execution, planning, financial management (collection of user charges, and so on), and operation and management of the test project. The Saradi test project was completed in all respects and dedicated to the villagers in November 2008.

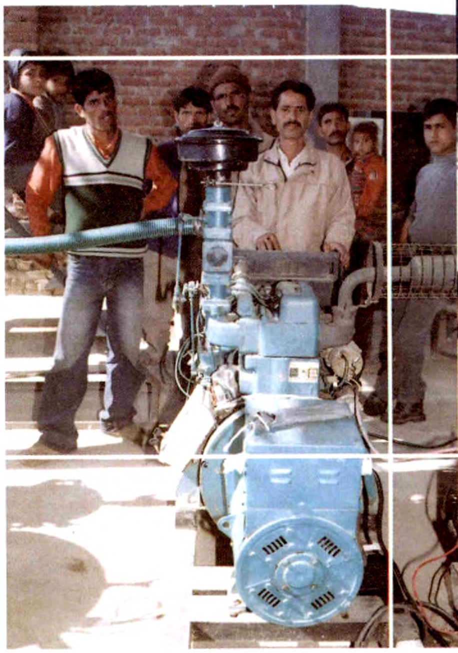
Two 10-kW capacity biomass gasifiers have been installed to generate electricity. The biomass gasifiers meet the daily requirement of domestic lighting in 106 households, community hall/school lighting, street lighting, and other entertainment activities. Each household has been provided with two light points and one power point for domestic lighting and entertainment. One oil expeller installed in the project, is being operated on 10-HP motor for extraction of oil from jatropha seeds. In addition, the villagers also make full use of oil expeller to extract oil from mustard oil seed. The oil extracted from jatropha seeds is being used by the villagers as raw material for operating their diesel engine pump sets directly for irrigation purpose. The fear of wild animals has reduced since 10 streetlights have been installed in the village, which provide adequate illumination during night. This has brought a sea change in their outlook towards development of their village.

The villagers have decided to use the power generated for many other applications, such as flour mill, chafe/fodder cutter machines, and water pumps. The VEC has undertaken plantation of jatropha in seven-hectare land, which would provide biomass for running the gasifiers and oil seeds for running the oil expeller. Five biogas plants, each of four cubic metre capacity, have been installed and the generated gas is being used for cooking. About 106 improved chulhas have also been distributed to the villagers.

With the introduction of electricity in the village, the quality of life of the villagers has improved drastically and villagers are happy as they have installed televisions in their houses for entertainment and their children are able to study at night in proper light. The smiles on the faces of the villagers after introduction of electricity speak volumes about the success of the project.

General details about the project

Name of the village	Saradi
Census code	00480100
Block	Kalsi
District	Dehradun
Access	Nearest road head: 5 km Chibru Power House Nearest rail head: 70 km Dehradun
Distance from grid line	20 km at Dhansai
Total households	106 (46 SC and 60 ST)
Population	533
Level of education	12th Pass – 1 (SC), 10th Pass - 7 (ST),
8th Pass - 4	
Educational institution	Primary school
Community centre	Panchayat Ghar - 1



Interview with

Dr Bhaskar Natarajan

former Senior Project Officer, ICEF

*Renewable energy products are still in their initial stages. There is a need for developing performance standards and these have to be accepted by the manufacturers, feels **Dr Bhaskar Natarajan**, Country Manager, India, ECO-Asia Clean Development and Climate Program. Dr Natarajan has previously worked on developing and directing the national energy management policy and programmes as the Director of the Energy Management Centre. He has also provided key inputs for the drafting of the legislation for energy efficiency (now passed as the Energy Conservation Act 2001).*

Q.1 You have been at ICEF (India–Canada Environment Facility) for several years. How much fruitful has been this partnership between India and Canada in the energy sector so far?

A. I have been with ICEF for over 9 years (I left in January 2008) and it has been an extremely fruitful and learning experience in ensuring that renewable energy projects have been taken to remote locations, where very little external development assistance has been received.

Q.2 Your association with the fields of energy efficiency and renewable energy technologies dates back to many decades now. What according to you has changed essentially between then and now moreso on the renewable energy specific industry, market, and financing fronts?

A. Between then and now technologies have developed in terms of efficiency (increased) and costs (these have gone down). Availability has also improved with more manufacturers coming into the markets. Consumer awareness on products, performance has also gone up tremendously and the demands from the consumer are driving products to greater levels of performance. Financing too has come of age, with financial institutions getting ready to address this segment of the markets.

Q.3 Utilization of RE products and systems as one of the effective energy conservation measures is often not seen in unison. When is that situation likely to change in a major way? Have you initiated any such activities as a part of larger ICEF objectives by now?

A. Since ICEF was involved in the rural areas, as a means of providing energy through renewable sources, this issue of conservation was not directly addressed. It was partly addressed through the use of energy-efficient chulhas that would consume reduced amount of biomass. Also, use of solar cookers does lead to energy conservation. ICEF really did not enter the larger markets for commercial and industrial systems.

Q.4 High-pressure sodium vapour lamps are seen working even under the flow glare of sun at times may be for one reason or the other. Do you see solar operated sensors useful in switching off such unwanted operation across the city of Delhi for example?

A. Timers are a cheaper and more reliable option for street lighting all over the country. The reliability of solar sensors is suspect and they will not operate under dusty conditions.

Q.5 Could you kindly share with us the most potential possibilities that could bring the areas of energy efficiency and renewable energy together?

A. Solar water heating has the largest potential, and so does decentralized generation through biomass option. These two combined can possibly save more than a 1000 MW in a state. However, there is a need for a large market push, and simply giving loans at low interest has not moved the markets. The push needs to come from the government in terms of placing large orders, and this would make the manufacturers make investments in new capacities.

Q.6 How much useful has been the recent initiative of the Government of India (BEE specifically) to give star rating to the conventional appliances on the basis of their performance? Do you feel any such drive can categorize the renewable energy products for a better acceptability and outdoor reliability?

A. Renewable energy products are still in their initial stages, and the star rating will have to wait for some time. There is a need for developing performance standards and these have to be accepted by the manufacturers. This would be followed by the development of performance levels, which would lead to star ratings.

Q.7 Could you kindly enlighten the readers with your key observations on the ICEF funded project on 'Integrated development of Durbuk block using Renewable Energy' in the frontier area of Ladakh?

A. The ICEF assisted project 'Integration Development of Durbuk Block Using

Renewable Energy Resources' began in April 2003. The project was jointly supported by ICEF, MNRE, and LAHDC. The project was expected to install 80-kW solar grid power plant to replace the existing diesel power station. The existing distribution lines were retained. For the harsh winters, 1000 homes were to be provided with trombe walls and chulhas. Thousand households were also to be encouraged to use solar cookers. For community applications, solar water pumping for drinking water and also medical centres with solar medicine storage facilities were proposed.

If one were to look at the progress, the 100-kW SPV power plant has been successfully commissioned and is generating electricity from 26 February 2005. Dish-type solar cookers have been procured and given to over 300 households who had paid the initial installment of 25% of the cost of the cookers. Improved chulhas have also been provided to 300 households in the project area.

Drilling for five tubewells has been completed and these will be fitted with solar PV pumping systems for providing drinking water to the households. Two solar refrigerators have been procured for storing medicines and other critical vaccines required by the health centre.

> *"There is a need for developing performance standards and these have to be accepted by the manufacturers. This would be followed by the development of performance levels, which would lead to star ratings"*

Two major highlights of the project need special mention. The first is the individual contribution to adopt energy saving devices and community contribution towards construction of eco tourism huts, groundwork for installation of water pumps etc. The second intervention that seems to have made a dramatic impact is the replacement of diesel-run power station with solar energy resulting in reduction in power generation expenditure, carbon emission, and regularity of power supply even during winter.

Q.8 In your expert view, what would you recommend between a CFL and LED as a lighting component in a solar lighting system from the important considerations of technology reliability, scope for energy saving, cost and importantly and affordability for replacement in a rural habitat mainly?

A CFLs are superior in terms of their light distribution and with suitable reflectors, this can be improved significantly. LEDs have the disadvantage that they are literally point sources and thus they have very limited range, and diffusion. LEDs need reflectors that can help diffuse the light and only then can they become comparable to the CFLs, not to speak of the costs.

Q.9 Kindly list down a few most important factors, which could go a long way in taking renewable energy industry/programme to new heights in the time ahead.

A The following factors can make renewable energy programmes and industry leapfrog in the times to come.

a. Government placing large orders from the public sector
b. Targets to be set for financial institutions
c. Regulators providing incentives for use of renewable energy technologies
d. Simplifying the documentation required for processing loans, similar to the ones credit card companies use for loans
e. Test certificates for products to be put up on related websites of MNRE, BIS, and other such bodies
f. Large-scale awareness campaigns targeted at various consumer groups with specific focus on feedback on investments.

First Solar Energy Fair organized

The first Solar Energy Fair (Saur Urja Sabha) was organized at B/1 Vasant Kunj Community Centre on 8 February 2009. The event was held under the patronage of MNRE, AIWC South West Branch and World Energy Council –Indian Member Committee (WEC-IMC). EE&REMC and IIT Delhi, CRDT had also confirmed its support for the event. Residents of the colony also turned up in great numbers to support this venture. Mr Deepak Gupta, Secretary, MNRE inaugurated the fair. This was followed by an interactive programme wherein after the welcome by Ms Lalita Balakrishnanan, Head (Rural Energy), AIWC, an outline of the benefits of solar equipment /appliances was presented to the residents by Mr J K Mehta, GM(WEC-IMC). The uniqueness of the programme lay in the fact that one of the manufacturers Mr Manoj from M/s Maharishi Electronics; the only woman entrepreneur in solar appliances Ms Anjani Goel, Banker; Mr Sadhu from Syndicate Bank; and the actual users of solar cooker and solar heating water systems shared their experiences. Ms Carol of the National level Youth Group of Climate Change Foundation shared her experiences of their Bharat Yatra in a solar-operated battery car and the initiatives that they were taking to promote of renewable energy amongst the youth of the country. Her REVA attracted a lot of residents who took a ride in the same.

Mr Deepak Gupta in his address urged people to go solar and expressed his disappointment that in spite of the various financial incentives and subsidies offered by the ministry and the Delhi government, the urban community was not exploring it as a viable option. Hailing Vasant Kunj as the intellectual capital of Delhi, he sought their support for making a beginning in this nationwide campaign and complimented the organizers for initiation of this venture and transforming 'advocacy to action'.

After this programme, the participants got to taste delicacies such as kheer and pakoras cooked in a solar cooker. The Solar Energy Fair also had a quiz programme for the participants and the residents and a painting competition for children and a couple of food stalls. Prizes in the form of solar appliances were given to the winners. The stalls and demonstration units were set up by six manufacturers namely, M/s Arsh Electronics, M/s Maharishi Electronics, M/s Bhambri Entrerprises, M/s Theme Solar, M/s Anu Solar, and M/s Bright Energy. About a dozen registrations were made on the spot for various solar appliances and keen interest was shown by everyone.

In continuation of the above initiative, the next such Solar Energy Fair was held as part of the International Week Celebration on 15 March 2009 at Vasant Enclave in association with AIWC, South West Delhi Women's Association.

A book on solar energy cooking was also released on the occasion, which was a compilation of recipes that can be cooked in a solar cooker.

ON 15th March 2009 AT 10.30 AM to 4.30 PM
Organised by
SOUTH WEST DELHI WOMEN'S ASSOCI
VASANT ENCLAVE WOMEN'S ASSOCIATIO
UNITY WOMEN'S ASSOCIATION
Sponsored

SIXTH INTERNATIONAL BIOFUELS CONFERENCE

WII (Winrock International India), a New Delhi based not-for-profit organization, organized the 6th International Biofuels Conference during 4–5 March 2009 in New Delhi. The conference, sixth in the series, has created a niche for itself and has over the years, become a vibrant and neutral platform for stakeholders from across the world. The two-day conference, this year, focused on topics that encouraged debate and deliberations on some of the most contentious issues facing the biofuels movement in India and globally. Spread over seven sessions, more than 35 papers were presented at the conference covering issues such as policy perspective on biofuels; food versus fuels debate; next generation biofuels; sustainability issues; and biofuels as a driver for rural development.

The conference witnessed participation from all over the world, including Germany, Switzerland, Japan, and Netherlands, among other countries. More than 300 delegates, from diverse sectors, including central and state ministries and agencies; financing and banking institutions; technology suppliers/developers; petroleum, sugar, alcohol/ethanol industries; edible and non-edible oil and automobile industry; NGOs and MFIs (micro-finance institutions); management advisors and entrepreneurs, made the conference highly interactive. A key highlight of the conference was the enormous student participation from a number of engineering and technology universities from all across India.

The conference was inaugurated by Mr Debashish Majumdar, Chairman and Managing Director, Indian Renewable Energy Development Agency Ltd, who in his inaugural address said that one of the factors for the success in the development of renewable energy for the power sector would be the development of a strong policy that also encourages investment, especially in the private sector.

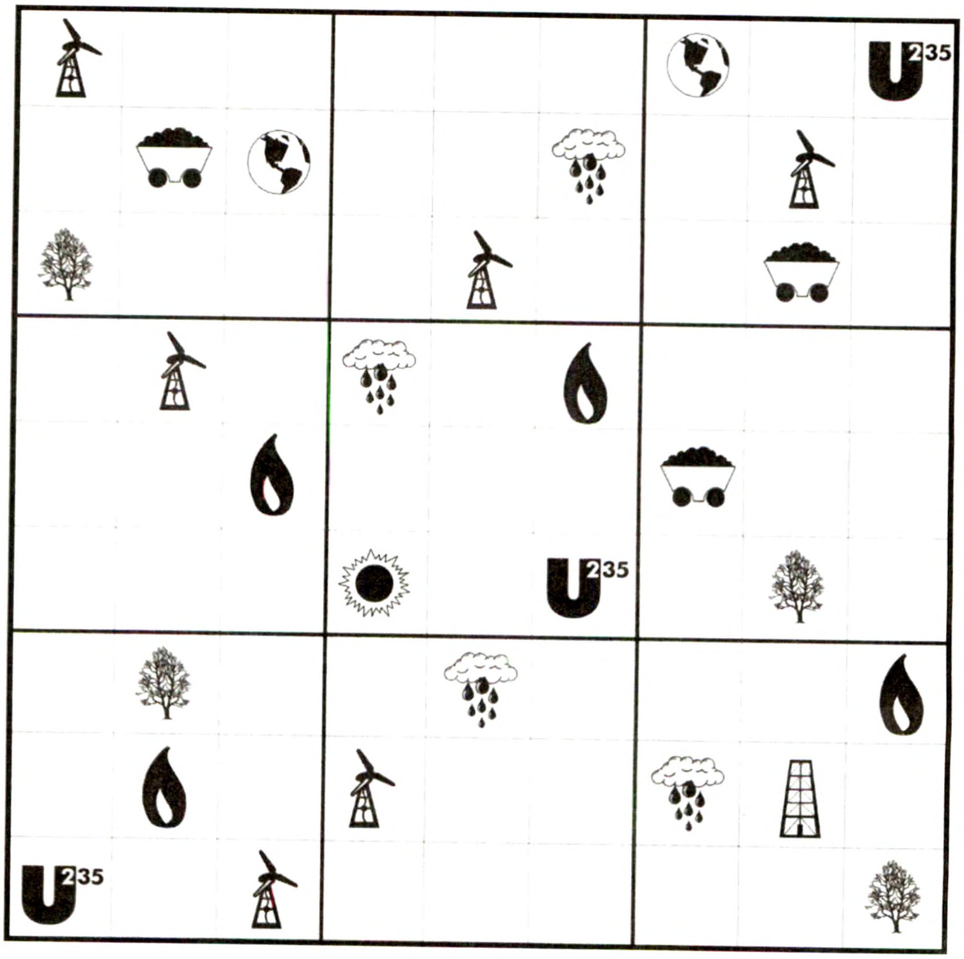
The conference agreed that advances in genetics, biotechnology processes, chemical, and engineering are leading to new concepts for converting renewable biomass to valuable fuels and other products. The conference also agreed that LCA (life cycle analysis) can be a useful tool for the consideration of environmental aspects of sustainability. Development of a data model would ensure that every producer of biofuels does not have to commission a full-scale LCA study.

It was repeatedly emphasized that a roadmap for alternative fuel use for India such that the product is available on a sustainable basis, should be prepared, to enable the auto industry to come out with optimized models. It was also felt that the bio-diesel industry could be much more attractive if the by-products of the industry are effectively utilized through the several technologies that are already commercially available. As large-scale plantations of jatropha are in existence in several Indian states, it was a positive sign that would lead to the availability of raw material for future processing plants. The future availability of lignocellulosic biomass, algal bio-diesel, and other renewable fuels could be expected to achieve breakthroughs in the very near future.

The outcome of the conference covered various aspects of the biofuels sector. Among them, in the Indian context, it came out that large-scale biofuel production could be a major driver for economic development but policy safeguards are needed to keep the biofuels programme consistent with existing land use and other planning required for multi-sectoral growth and development. Decentralized biofuels production and application, on the other hand, requires very few checks and balances and has the potential for being a major catalyst for rural development and addressing poverty, which in turn would have benefits in terms of improved livelihoods and thereby in conservation of forests and natural resources.

ENERGY SUDOKU

Sudoku is a logic-based placement puzzle consisting of a 9 × 9 grid of cells. Typically using numbers, this puzzle uses energy source symbols for biomass, coal, geothermal, hydropower, natural gas, petroleum, solar, uranium and wind. To solve the puzzle, each 3 × 3 region of the grid must contain only one source symbol. Each row and each column of the puzzle must contain only one energy source symbol. There is only one solution. Good luck!



Send in your answers to the following address. The first three correct entries will be published in the next issue of *Akshay Urja*.

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Ayush Mishra
23-A, Pocket - A
SFS Flats
Sukhdev Vihar
New Delhi – 110 025

A Narasamma
Accountant
Nehru Youva Kendra
Kolar
Karnataka – 563 101

Shashi Kumar
Class 9
GBS School
Railway Colony
Tughlakabad
New Delhi –
110 044

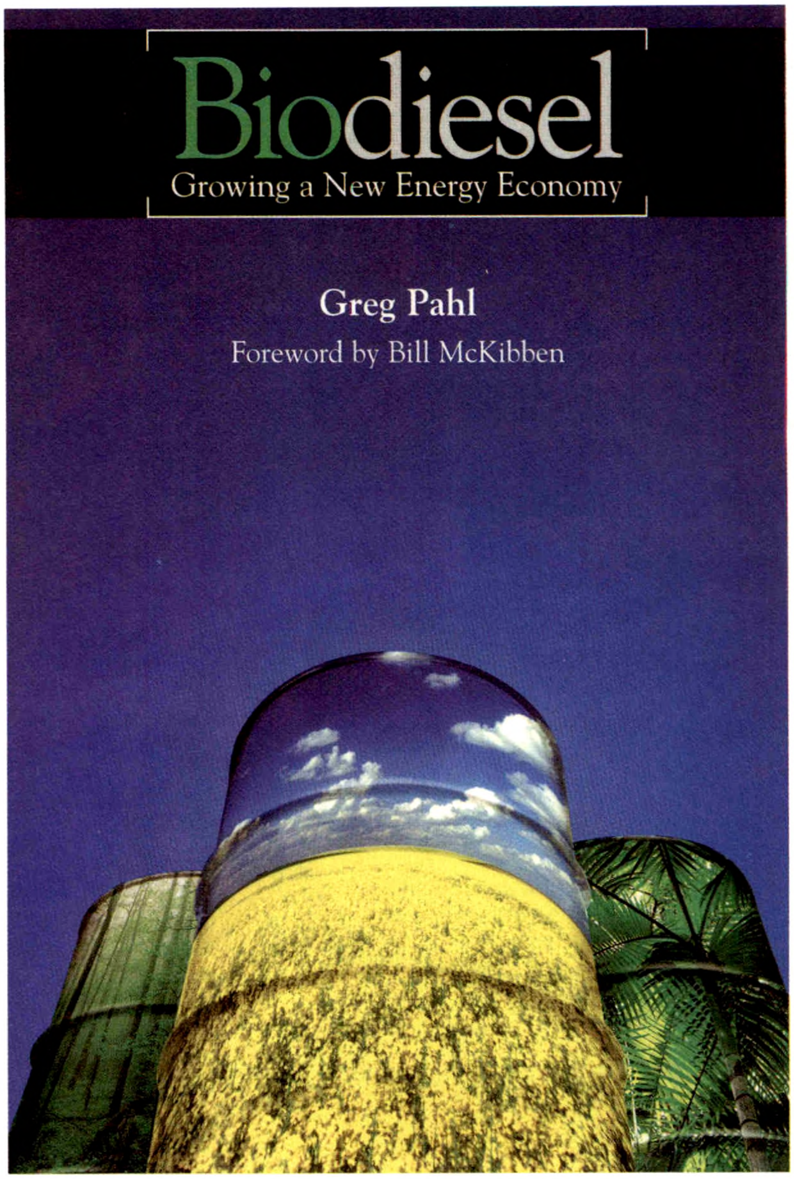
CONGRATULATIONS

Biodiesel:
growing a new energy economy

For a hundred years, we have powered our lives the easiest possible way—by tapping into those pools of hydrocarbons left by the eons. That energy is highly concentrated and easily portable. It was just waiting there, for us to come along and scoop up, so we did. Now we have begun to realize that petroleum can't be what we use to power our next century. Not only is the supply starting to dwindle, but it's also become clear just what a high environmental price we have paid for the convenience. If nothing else, the news that our planet is likely to warm five degrees this century should be enough to set us looking for new paths.

Bio-diesel is one of the most intriguing of those possibilities. For ancient biology, compressed by the weight of time into petroleum, it substitutes present-day biology: crops of soybean and rapeseed and maybe even algae, grown by present-day farmers, processed into a diesel fuel substitute that works just fine in modern Volkswagens and Mack trucks and school buses—even in the oil-burning furnace down in the basement. Greg Pahl's book, though it is impeccably careful and well-documented, nonetheless brims over with a justified excitement at the possibility of this homegrown energy.

It also manages to raise the right questions (and raise them early enough) so that we can perhaps build a structure for this developing industry that serves local farmers and processors instead of simply corporate agribusiness giants: since this project is largely dependent on public funding for a jumpstart, that is not too much to ask. In this essential book, Greg Pahl shares the history of bio-diesel, explains the technology in straightforward terms, and explores its exciting potential in the US and beyond, including resources you can use to buy or make your own bio-diesel.

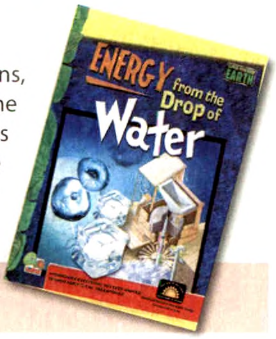


Biodiesel: growing a new energy economy
Pahl G. 2005
ISBN: 1-931498-65-2 • Price: Rs $17.64
United States: Chelsea Green Publishing

Super-powered earth: Energy from the drop of water

Benita Sen. 2008

Published by TERI and MNRE



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Super-powered earth: Energy from the heart of hydrogen

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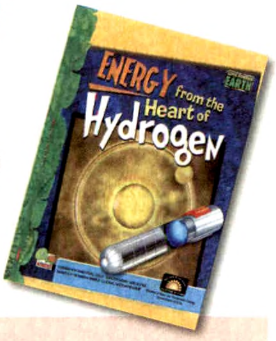


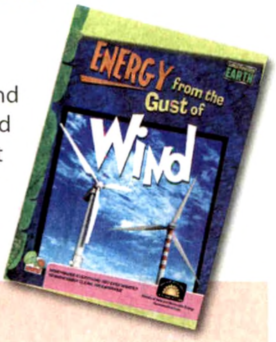
Hydrogen is the simplest element we know. It's in water and in the earth's crust, and now, it's in the hydrogen fuel cell. What is hydrogen fuel? Can we replace fossil fuels with hydrogen? This book explains why hydrogen is hot, hot, hot!

ISBN 978-81-7993-140-0 • Price: Rs 150
Age group: 11-15 yeras

Super-powered earth: Energy from the gust of wind

Benita Sen. 2008

Published by TERI and MNRE



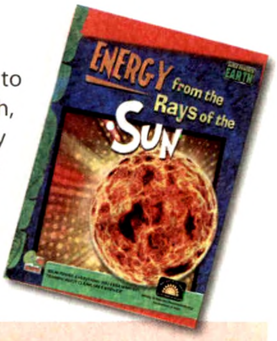
It tousles your hair, blows your balloon away, and scuttles clouds along the sky. Millers have ground corn in windmills with the help from wind. And it still has a lot of energy to spare, blowing rooftops off and flattening trees during a storm. Can we make the wind work more for us? Find out how!

ISBN 978-81-7993-135-6 • Price: Rs 150
Age group: 11-15 yeras

Super-powered earth: Energy from the rays of the sun

Benita Sen. 2008

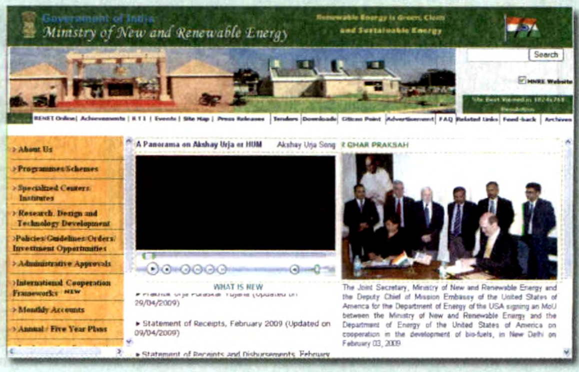
Published by TERI and MNRE



It's not just plants that use the sun's energy to make their food. So can we. And we can do much, much more. From Roman baths to modern-day spacecrafts, we have found ways to use the sun's light and heat. Yet, even today, we are able to capture only 1% of this energy. Find out how we can make the most of the sun, and why that's important for our planet.

ISBN 978-81-7993-137-0 • Price: Rs 150
Age group: 11-15 yeras

Internet resources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A Panorama on Akshay Urja or HUM
Akshay Urja Song
GHAR PRAKSAH
WHAT IS NEW

29/04/2009)

Statement of Receipts, February 2009 (Updated on 09/04/2009)

The Joint Secretary, Ministry of New and Renewable Energy and the Deputy Chief of Mission Embassy of the United States of America for the Department of Energy of the USA signing an MoU between the Ministry of New and Renewable Energy and the Department of Energy of the United States of America on cooperation in the development of bio-fuels, in New Delhi on February 03, 2009

http://mnre.gov.in/

MNRE website: a one-stop-shop for information

Renewable energy is green, clean, and sustainable energy. This is the opening line on the website of the MNRE (Ministry of New and Renewable Energy). The website is a one-stop-shop for information on the ministry and its activities. The website opens with a link to the Akshay Urja song, which rightly portrays the MNRE's mission Akshay Urja se Desh Vikas, Gaon Gaon Bijli Ghar Ghar Prakash. The left hand side of the website gives an immediate picture of all that the website has to offer to the user. Just below the Akshay Urja song video is a window where the user can see update information on the latest schemes and other recent announcements from the ministry. The tabs on the left hand side of the page show all that the website has to offer.

The 'About us' section gives information on who's who at the ministry, the address of regional offices, major achievements, videos and photo gallery of various events, and information on who to contact for what purpose at the ministry. The next tab provides information on the programmes and schemes of the MNRE. Right from renewable energy for rural applications to support programmes for renewable energy this section has everything to offer in terms of all the programmes on renewable energy that it supports. Further down, there is also information on the specialized centres and institutions of the ministry; policies, guidelines, orders, and investment opportunities; and international cooperation frameworks.

There is also a comprehensive list of manufacturers, industries, and architects; and also a soft copy of its various reports and publications. All in all the website is a very comprehensive source of information on the ministry.

National events

Renewable Energy India 2009 Expo

10–12 August 2009, New Delhi

Rajneesh Khattar
Exhibitions India Group
217-B, (2nd Floor)
Okhla Industrial Estate
Phase III, New Delhi – 110 020
Tel. +91 11 4279 5000/054
Fax +91 11 4279 5098/99
E-mail rajneeshk@eigroup.in

Empower India 2009

20-22 August 2009, Mumbai, India

Urjavaran Foundation
128, Arun Chambers
Tardeo, Mumbai - 400 034
Tel. 022 6596 9852, 2353 1695
Fax 022 2351 1825
E-mail empower@urja.org.in
Web www.urja.org.in
Event website www.empower-india.com

Third Renewable Energy Finance Forum

20–21 November 2009, Mumbai

Maria Ferreiro
E-mail mferreiro@euromoneyplc.com

Methane to markets: partnership expo

2-5 March 2010, New Delhi

Tel. +1 (202) 343 9683
E-mail asg@methanetomarkets.org

International events

SNEC PV Power Expo 2009

6–8 May 2009, Shanghai, China

Tel. 86 159 21921158
Fax 86 21 511882-00
E-mail cathychu2007@163.com
Web www.snec.org.cn

Solar 2009

8–14 May 2009, Buffalo, New York, USA

Tel. 1 303 443 3130
Fax 1 303 443 3212
E-mail ases@ases.org
Web www.ases.org

Solar 2009

12–16 May 2009, Buffalo, New York

Tel. 1 303 443 3130
Fax 1 303 443 3212
E-mail ases@ases.org
Web www.ases.org

ESTEC 2009

25–26 May 2009, Munich, Germany

European Solar Thermal Industry
Federation, Renewable Energy |
House, Rue d'Arlon 63-67
B-1040 Bruxelles
Belgium
Tel. 3 225 461 937, *Fax* 3 225 461 939
E-mail info@estif.org
Web www.estif.org

Intersolar 2009

27–29 May 2009, Munich, Germany

Tel. 49 7231 58598-0
Fax 49 7231 58598-28
E-mail info@intersolar.de
Web www.intersolar.de

Solar Taiwan 2009

10–12 June 2009

Taipei, Taiwan
Tel. 886 2 2351 4026 (Extn 805)
Fax 886 2 2396 8513
E-mail pamela@mail.pida.org.tw
Web www.optotaiwan.com

Wind Expo 2009

2–4 September 2009, Panama City, Panama

Av. Terranova 1091-2
Guadalajara México
Tel +52 33 3817 8300
Fax +52 33 3817 8758
Web http://www.windexpo.org/2009/ing/index.html]

24th European Photovoltaic Solar Energy Conference & Exhibition (EU PVSEC)

21–25 September 2009, Germany

WIP-Renewable Energies
Conference Secretariat
Tel. +49 89 720 127–35
E-mail pv.conference@wip-munich.de

Solar Power 2009

27–29 October 2009, Anaheim, California, USA

Tel. 1 202 857 0898
Fax 1 202 682 0559
E-mail ebrown@solarelectricpower.org

Congress on Alternative Energy Applications

2-6 November 2009, Kuwait

Dr Salah Almudh'hi
Web http://www.ec2009kuwait.org/

Renewable energy at a glance in India

S.No.	Source/system	Estimated potential	Achievement as on 31 March 2009
I	**Power from renewables**		
A	**Grid-interactive renewable power**	(MW)	(MW)
1	Wind power	45 195	10 242.50
2	Bio power (agro residues and plantations)	16 881	703.30
3	Bagasse cogeneration	5 000	1 048.73
4	Small hydro power (up to 25 MW)	15 000	2429.67
5	Energy recovery from waste (MW)	2 700	58.91
6	Solar photovoltaic power	—	2.12
	Sub total (A)	**84 776**	**14 485.23**
B	**Captive/combined heat and power/distributed renewable power**		(MW)
7	Biomass/cogeneration (non-bagasse)	—	170.78
8	Biomass gasifier	—	105.46
9	Energy recovery from waste	—	34.06
	Sub total (B)	**—**	**310.30**
	Total (A+B)	**—**	**14 795.53**
II	**Remote village electrification**	—	5 453 villages/hamlets
III	**Decentralized energy systems**		
10	Family-type biogas plants	120 lakh	41.27 lakh
11	Solar photovoltaic systems	50 MW/km^2	120 MWp
	i. Solar street lighting system	—	70 474 nos
	ii. Home lighting system	—	450 000 nos
	iii. Solar lantern	—	730 000 nos
	iv. Solar power plants	—	8.01 MW_p
	v. Solar photovoltaic pumps		7148 nos
12	Solar thermal systems		
	i. Solar water heating systems	140 million m^2 collector area	2.90 million m^2 collector area
	ii. Solar cookers		6.57 lakh
13	Wind pumps		1347 nos
14	Aero generator/hybrid systems		0.89 MW_{eq}
IV	**Awareness programmes**		
16	Energy parks	—	511 nos
17	Aditya Solar Shops	—	284 nos
21	Renewable energy clubs	—	521 nos
22	District Advisory Committees	—	560 nos

MW – megawatt; kW – kilowatt; MW_p – megawatt peak; m^2 – square metre; km^2 – kilometre square

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For more details contact

Energy Efficiency and Renewable Energy Management Center
Department of Environment
1st Floor, DFC Building, Plot No. 37-38
Pankha Road, Institutional Area, D - Block
Janak Puri, New Delhi - 110 058.
Phone: 011-28525035-39 Website: www.environment.delhigovt.nic.in

अक्षय ऊर्जा से देश विकास

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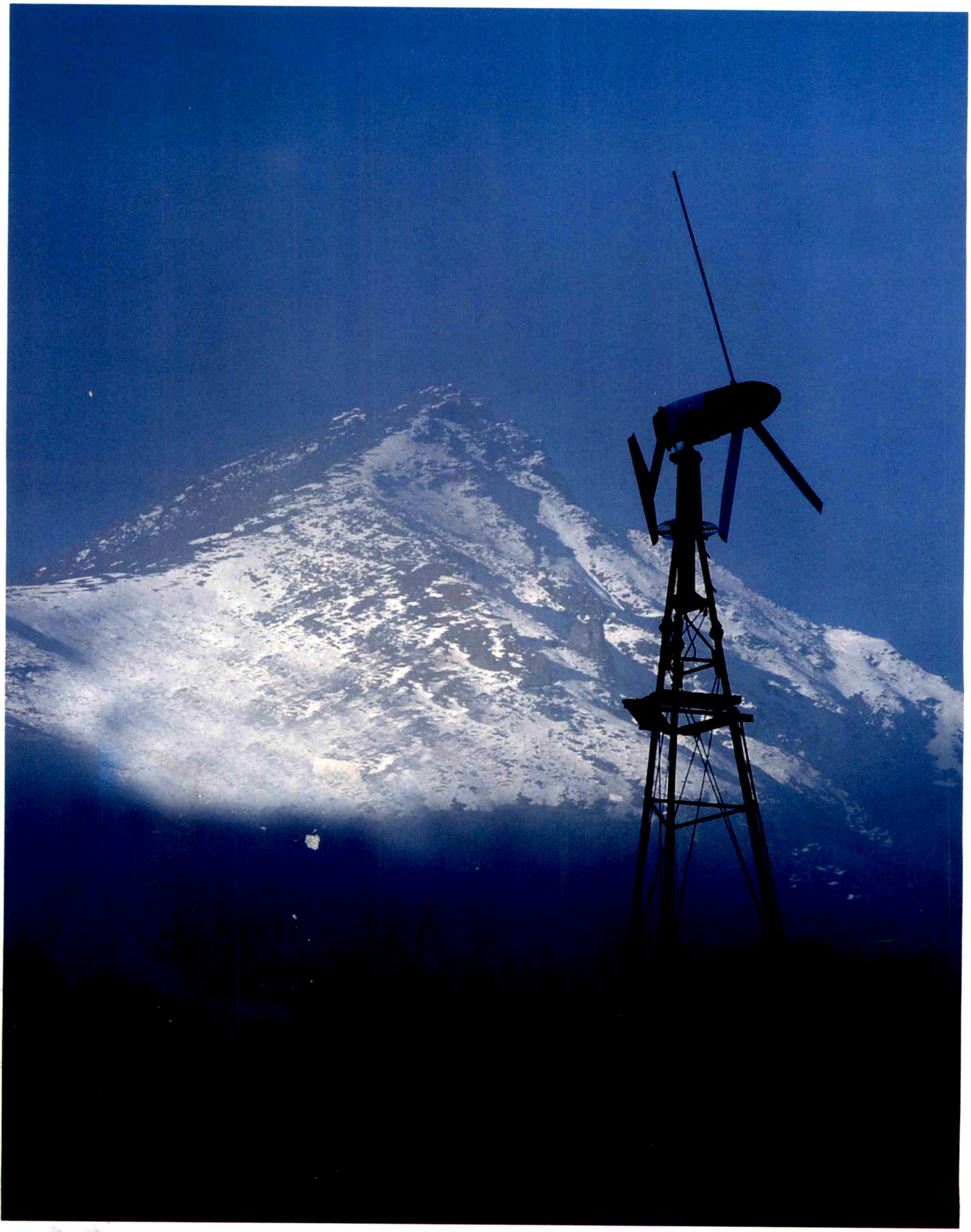
Use Renewable Energy

Use solar water heater to conserve electricity

RNI No. DELENG/207/22701



Wind Aerogenerato at 14000 ft altitude from the mean sea level at Thangu, North Sikkim
Capacity 10 KW

Renewable Energy

Akshay Urja

Volume 2 ▪ Issue 6
June 2009

अक्षय ऊर्जा से देश विकास
गांव गांव बिजली, घर घर प्रकाश

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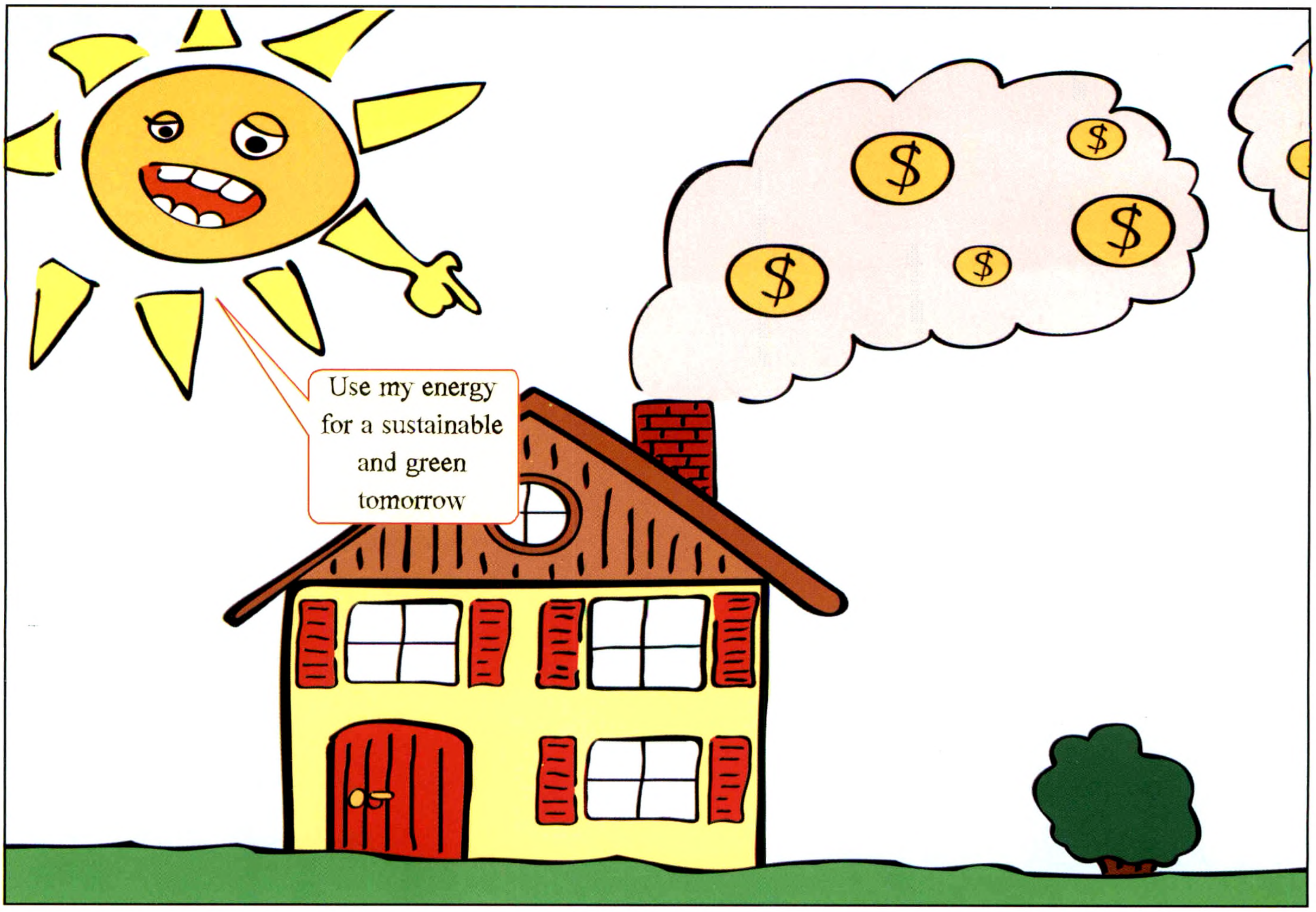
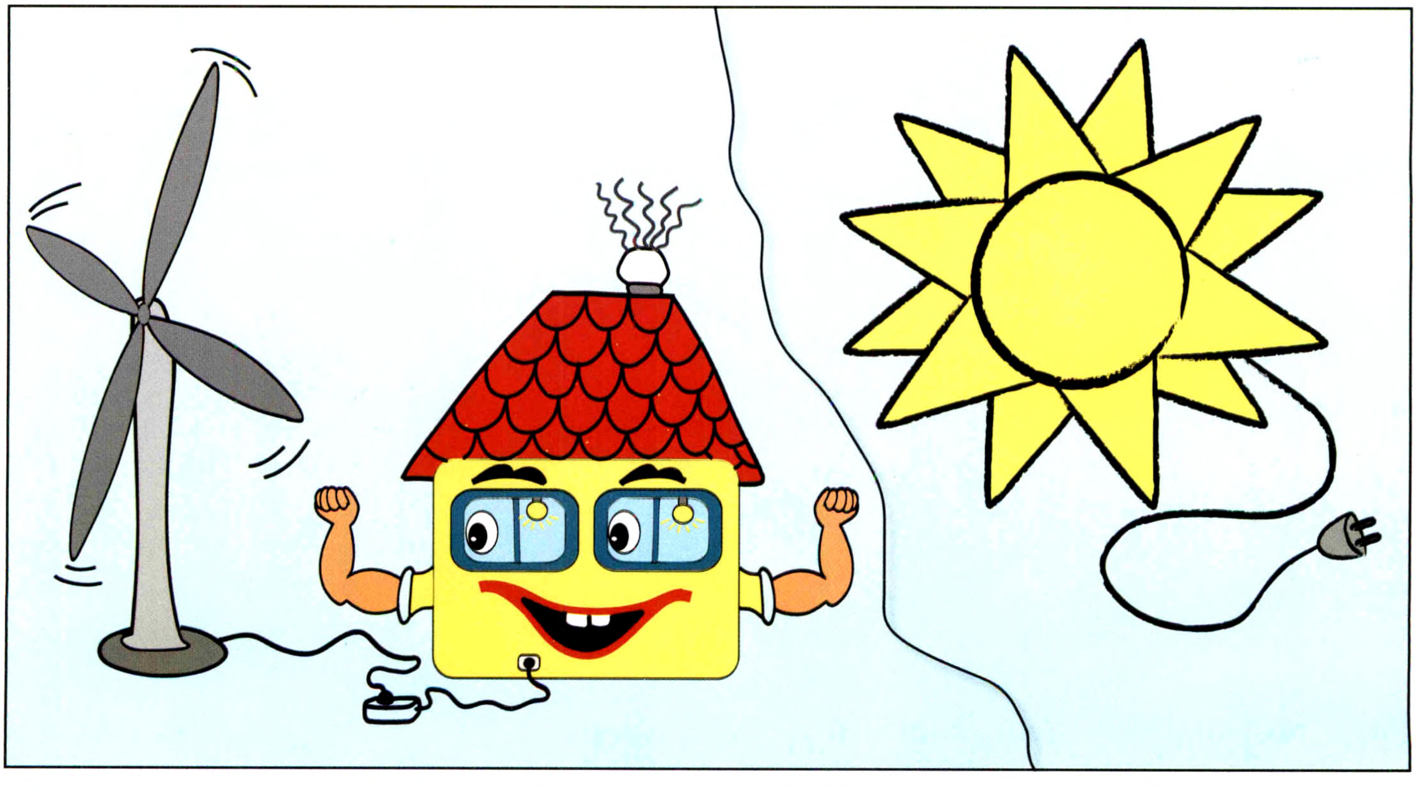

Use my energy
for a sustainable
and green
tomorrow



Renewable Energy
Akshay Urja

Volume 2 • Issue 6 ▪ June 2009

A bi-monthly newsletter of the Ministry of New and Renewable Energy, Government of India

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Disclaimer
The views expressed by authors including those of the editor in this newsletter are not necessarily the views of the MNRE.

Dear Reader,

The growing demand for energy has necessitated the finding of alternative sources for meeting the demand in urban and rural areas. With the change in the rural scenario and agricultural practices, and the advent of gadgets like televisions, mobile phones, and computers, the demand of energy has also increased manifolds. Today, people living in rural areas need round-the-clock electricity supply, have LPG for clean cooking, enjoy films and other entertainment events on television, study and work at late hours in the night, and so on. The rural industry also needs energy for optimum production. But, it is not happening in reality, and as a result, we are witnessing a large-scale migration of people from villages to cities. If we can provide adequate energy/electricity to our rural areas, it can check migration and thus, help to reduce the increasing load on the cities.

The Indian government is toiling to provide sufficient electricity, cooking gas, petroleum oil, coal, kerosene, and other such fuels to meet the growing demand of rural areas. However, due to limited resources, difficult geographic conditions, and remoteness of villages, the reach is limited. In this scenario, RE (renewable energy) has proved to be a ray of hope for resolving the energy problem in rural areas. Energy is mainly required for cooking, heating, lighting, motive power, irrigation, small cottage industry, agricultural operations, and drying in rural areas. RE can play a vital role in meeting the energy demands for these end-use applications.The MNRE (Ministry of New and Renewable Energy) is promoting RE applications in rural areas through various fiscal and financial incentives, including concessional interest-based loans.

In addition to the government's efforts, the corporate houses and private sector companies should also come forward and adopt remote villages as per their capacity for creating the basic infrastructure facilities, including sustainable supply of energy. This will not only connect the remote villages with the entire world, but also provide them equal opportunity for further progress in every field.

I am sure that you will find *Akshay Urja* informative and useful. We invite your valuable suggestions and contributions for enriching the forthcoming issues of the magazine.

ARUN K TRIPATHI
<aktripathi@nic.in>

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LETTERS TO THE EDITOR

We are a leading distributor and dealer of solar products. We found your magazine very useful to us for information of product and manufacturers. So kindly send us this bi-monthly regularly.

G B Srivastava
Equipment Sales and Service
228, A L I C Colony, Tagore Town
Allahabad - 211002

Bharathiya Kisan Sangha, Dakshina Kannada, is a farmers' organization. The organization maintains a library on agriculture and related issues. Books and journals focusing on topics, such as organic farming, soil and water conservation, environment, and law, have been arranged in the library for the reference of the general public, particularly farmers. So, I request you to generously contribute related books and help us in expanding the library. Please send your magazine Akshay Urja regularly to our library.

General Secretary,
Bharathiya Kisan Sangha, D K,
R K Building, Mandir Road, Puttur,
Dakshina Kannada, Karnataka - 574201

I am extremely eager to subscribe to the bi-monthly magazine of the Ministry of New and Renewable Energy—Akshay Urja. I am a student of Electronics Engineering (3rd year) from Jiwaji University, Gwalior, with great interest in solar energy. Hence, Akshay Urja would be immensely beneficial for me. I shall be thankful if you please send the publication (from January 2009 if possible).

ShreeChandan Panda
Jiwaji University, Gwalior

I am a Student of MSc Physics in NIT Jalandhar. I am very influenced and motivated by your Akshay Urja, and I want to subscribe to it (English version).

Arvind Kumar
73/2, Sanjay Gandhi Nagar,
Jalandhar City, Punjab

As I am greatly interested in the operational system of solar products and schemes of the Ministry in regards to harnessing solar energy, I would like to request you to send me every copy of Akshay Urja's future publications.

K Kham Minthang
Nhathal Village, B P O Kawnpui,
Churachandpur, Manipur – 795128

We, Turbomachinery Engineering Industries Limited, recently chanced upon your newsletter Akshay Urja and found the information therein useful for our focus on renewable energy-related projects. In order to keep abreast with the latest developments taking place globally and in our country, we would like to subscribe to your newsletter Akshay Urja.

PK Mathur
General Manager (Projects)
Turbomachinery Engineering Industries
Ltd, 309, IDA Bachupally, Hyderabad

On a recent visit to the CGO complex in Delhi I read a copy of Akshay Urja. I am a project consultant and I found the information of immense use to me. May I request you to include my name on the mailing list of the newsletter?

Devendra S Kothari
Flat 4A, Lav Kush Apartments
2/1, Beltala Road, Kolkata 700026

सर्वप्रथम आपको अक्षय ऊर्जा नामक पत्रिका की शुरूआत की बधाई देता हूं। इस पत्रिका को पढ़कर ऐसा लगा जैसे कि हम, सुदूर गाँवों में आज के नए आविष्कारों से अपरिचित है। यह पत्रिका की शुरूआत एक दिन मील का पत्थर साबित होगी। महोदय आपसे प्रार्थना है कि 'हरित भवन' और 'भू ताप पंप' के बारे में अगले अंकों में विस्तार पूर्वक लिखें। साथ ही मुझे जानकारी दें कि अक्षय ऊर्जा क्लब की स्थापना किस तरह से की जाए ताकि हम अपने और अपने पड़ोस के गांवों तक इन नई तकनीकों और विधियों को पहुंचा सकें।

भवदीय, **राजेश शर्मा**,
सुपुत्र श्री राम सरूप शर्मा
गा. व. डा. टक्का, त. व. जि. ऊना,
हिमाचल प्रदेश – 174303

महोदय मैं अक्षय ऊर्जा उपकरणों के व्यापार में हूँ। अक्षय ऊर्जा पत्रिका बहुत ही उपयोगी जानकारी उपलब्ध है।

कृपया हमें भी पत्रिका भेजने की व्यवस्था करें जिससे हम स्वयं और अन्य को भी नई–नई जानकारियों से अवगत करा सकें।

आपका

धीरेन्द्र विक्रम कुशवाहा

Dear Reader,

Thank you very much for your encouragement. The editorial team of *Akshay Urja* will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvement in terms of content and presentation.

Editor
Akshay Urja

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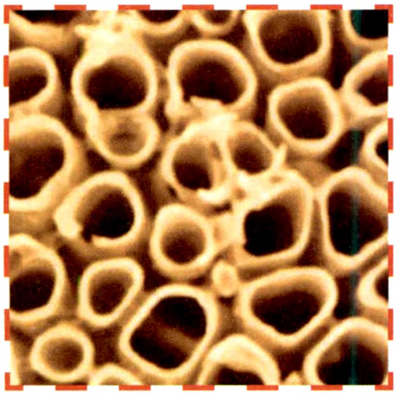

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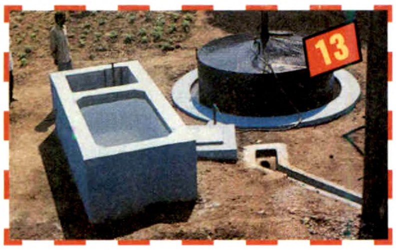

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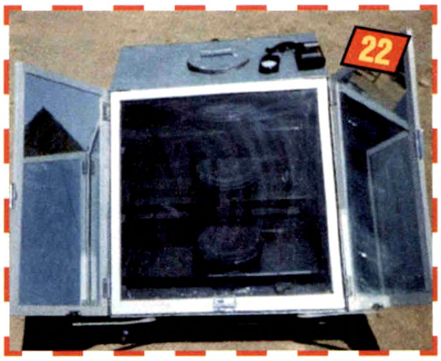

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Proposal to introduce solar invertors

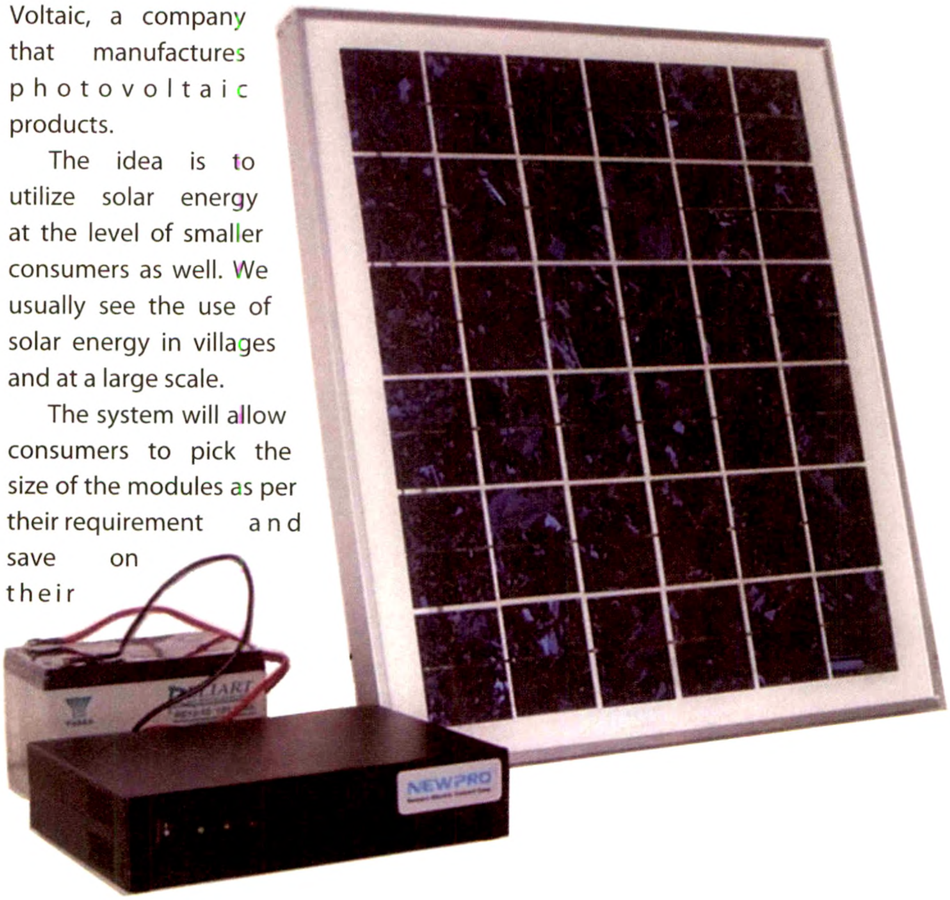
The Delhi government's power department is mulling over a proposal to introduce solar panels for recharging batteries used to run appliances of everyday use during power cuts and outages. The proposal comes at a time when the department has been stressing the need to use more green energy and reduce dependence on non-renewable energy. An official of the power department said the concept is similar to that of a solar water heater. 'Solar panels are used to draw the energy of the sun to run appliances just like an inverter does. While an inverter uses energy from the grid to recharge the battery, here the battery gets recharged from solar energy, which is clean and economical,' he said.

The proposal to use solar energy to run the inverter has been put forth by Moserbaer Photo Voltaic, a company that manufactures photovoltaic products.

The idea is to utilize solar energy at the level of smaller consumers as well. We usually see the use of solar energy in villages and at a large scale.

The system will allow consumers to pick the size of the modules as per their requirement and save on their energy bills. 'The battery here will not require power from the grid to recharge; it will get re-energized even as it is being used from the solar modules attached to it. Apart from the initial investment (the cost of modules) the system does not incur any running costs,' says Mr Vermani.

A 100-watt module for instance requires a space of one metre square in dimension and costs about Rs 15 000. 'All it (modules) requires is a bit of cleaning once every few days so that the efficiency does not go down. The modules last for as long as 25 years'. To make the concept economically viable for consumers, the company has also proposed extending a subsidy to the buyers. 'To popularize solar water heating the government offers a subsidy to consumers. A similar formula should be worked out for the solar invertors as well, inverters are used in all kinds of weather and definitely more than the water heaters,' he said. Owing to the gap in the demand and supply of power in the city and its suburbs, the sale of invertors has been on the rise over the years.



THE HINDU

Indian Railways to generate 50 MW through solar power

The Indian Railways, which is actively exploring the possibilities of tapping non-conventional energy sources across the country to meet a portion of its ever-growing energy needs and executing a couple of projects in this direction at vantage points, will generate 50 MW of electricity from solar energy by installing the units at Nagpur in near future, Member/Electrical, Ministry of Railways, Sukhbir Singh has said.

Mr Singh was here to commission seven windmills, each with the capacity of 1.50 MW, installed at Kasthuriengapuram under Radhapuram taluk in Tirunelveli district. Mr Singh said the Indian Railways had installed four solar power units, each having the capacity of generating 1.90 MW, at Nagpur, one of the hottest places in the country that experiences even 47 degree Celsius during summer.

'Since we intend to tap the non-conventional energy sources in the maximum possible fashion in the wake of growing energy needs and increased power cuts, we have planned to install more solar power units at Nagpur to ultimately increase the total generation capacity to 50 MW,' he said. Mr Singh, while hinting that Indian Railways' windmills would come up on the coasts of Orissa and Tamil Nadu, also informed that more windmills would be installed in Radhapuram region so that the quantum of power generated by Indian Railways from this region would also go up substantially.

THE HINDU BUSINESS LINE

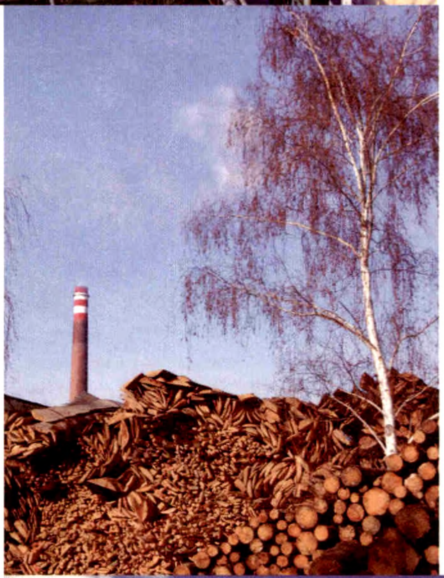
Biomass power procurement tariff increased to Rs 4.50

The tariff for biomass power procurement has been increased to Rs 4.50 per unit from Rs 3.15 per unit, the TNERC (Tamil Nadu Electricity Regulatory Commission) said in a press release. This increase makes the state's tariff the highest in the country for biomass power procurement. With an installed biomass power capacity of 147 MW out of the country's total of 683 MW, Tamil Nadu has one of the highest biomass power plant capacities in the country. But over the last two years, capacity utilization had declined sharply due to a steep increase in the cost of biomass fuels, the release said.

'The capacity utilization, which ranged from 5% to 70% during 2007/08, declined to 3% to 48% during 2008/09. Other users of biomass fuel have been procuring bio fuels at a much higher price making it unviable for biomass based power plants. This deficiency has been addressed by the Commission by fixing the fuel cost at double the present rate of Rs 1000 per MT,' the release said.

The new tariff order would also introduce a two-part power tariff based on fixed cost and variable cost, which has been in vogue in other states such as Maharashtra, Andhra Pradesh, and Rajasthan. The variable cost would account for variations in the cost of biomass fuel, the release said. The present tariff order had been arrived at after a consultative process that included discussions with experts, stakeholders, and a public hearing, the release added.

THE FINANCIAL EXPRESS



Hampi going fully solar

Hampi will be the first town to be completely powered by solar energy. Principal Secretary of Energy K Jairaj recently announced at Cliktronika 2009 – a renewable energy trade fair – that the plan has been finalized with BHEL (Bharat Heavy Electricals Ltd) and Hampi Development Authority.

K Jairaj also unveiled the state government's plan to invest in solar rooftop set-ups and making KREDL (Karnataka Renewable Energy Development Ltd) a single-window clearance agency for renewable energy projects.

Power minister K Eshwarappa said that the government is taking various

initiatives to change the power-starved state to a power surplus one. Plans are already afoot to create two solar cities—Hubli and Mysore. The state government's aim is to generate 6000 MW by March 2013, which would mean a generation of 1000 MW per year. 'It might seem ambitious but since Karnataka has no resources at all, we have to make it a reality. It can be done,' says Jairaj.

THE TIMES OF INDIA

'Green materials' to be mandatory for houses from 2010

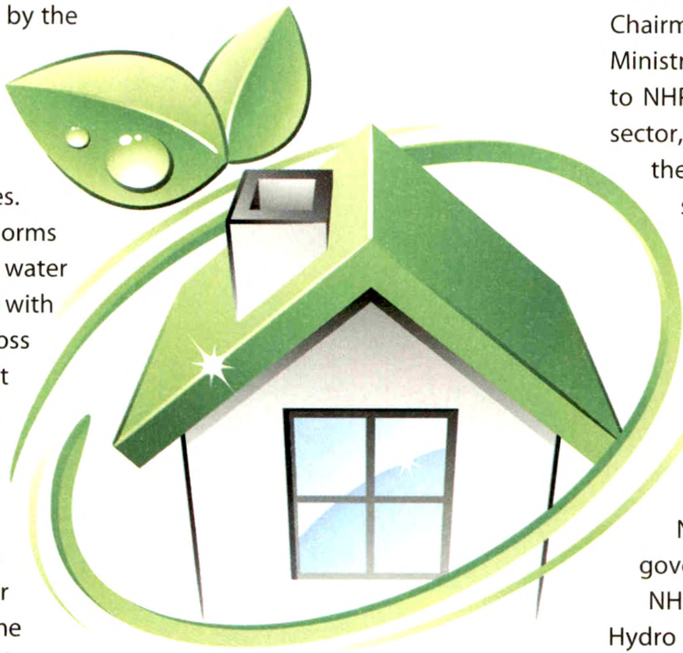
The construction and housing sector will get a tad greener by the end of the next year. The government has decided to make it mandatory for new buildings to undertake energy efficient measures, rainwater harvesting, and use recycled construction material in parts under the sustainable habitat mission of the national action plan on climate change. The government will also finalize norms for integrating parking, taxation, congestion charges, and other measures to promote public transport across different cities.

The mission report, finalized by the urban development ministry and cleared by the government, will now be presented to the Prime Minister's climate change council when it next convenes. At present, several different norms exist for energy efficiency and water harvesting and are implemented with a great amount of variance across different cities. The government will turn them into a unified national standard so that they can be uniformly applied across the country.

Realizing that urban development measures lie under state governments and not the Centre, the Union government plans to leverage the grants it makes under the JNNURM programme to get the states on board. The grants from the centre under the massive urban development programme will have built in conditions to ensure that the national standards are incorporated in the bylaws of cities utilizing the funds. The norms will mandate minimum energy performance standards for residential and commercial buildings. While questions about actual implementation of the norms at present remain questionable considering past experience, the government is looking at less coercive and inspection-based ways of turning the laws into practice.

The government plans to carry out a gamut of climate-friendly activities through the urban development ministry under the Eleventh Five-year Plan pilot projects. Demonstration programmes would also be carried out and separately budgeted for as part of the mission. The legal and regulatory measures that cover a broad spectrum of areas will be consolidated under the National Sustainable Habitat Parameters.

THE TIMES OF INDIA



NHPC to invest on wind energy in state

The state-run NHPC (National Hydroelectric Power Corporation) is planning to set up wind energy plants in Karnataka. 'As Karnataka has huge potential in wind energy, NHPC is keen to explore this,' said S K Garg, Chairman of the company. With the Ministry of Power granting permission to NHPC to invest in the wind energy sector, the company is foraying into the renewable energy segment by setting up wind energy parks in different parts of the country, including Karnataka. Some places in Gadag, Belgaum, and Chitradurga districts had been identified as the highest wind energy potential areas where NHPC was keen to invest. The chairman mentioned that NHPC would write to the state government in this regard.

NHPC's subsidiary NHDC (Narmada Hydro Development Corporation) is already in an advanced stage of setting

up two wind power projects in Madhya Pradesh. The NHPC had earlier proposed to set up a hydro power project in the Cauvery Basin, but it was later shelved due to the dispute between Karnataka and Tamil Nadu on water sharing.

DECCAN HERALD

UK–India sign research agreement on solar energy

Research is playing an increasingly significant role in promoting bilateral relations between India and the UK. Initiatives such as the UKIERI have shown how the two countries are taking an active step in promoting not only mutually beneficial and complimentary research but also better cultural understanding. A workshop on India–UK Cooperation in Solar Energy Research was organized at the Indian Institute of Technology-Delhi recently. The main aim of the workshop was to discuss the priorities for a multimillion-dollar joint initiative for collaborative research projects on solar energy—an agreement for which has been signed.

The delegates from UK included members of a consortium of universities working together on solar energy research. The Indian delegation comprised their counterparts from IIT-Delhi, Guwahati, Kharagpur, Kanpur, Mumbai, and Chennai; National Institute of Technology, Tiruchirapalli; and KIIT-Bhubaneshwar. The cooperation agreement signed during the workshop will act as a statement of intent to cooperate towards the fostering of genuine and mutually beneficial research collaboration in solar energy research through a multimillion-dollar research programme to be initiated in the coming months. The call for research proposals is likely to be made soon.

DECCAN HERALD

LDA plans to use solar energy for parks

LDA (Lucknow Development Authority) is going to install solar lights in 100 parks it is developing in the city. Officials believe that the lights will save up to Rs 3 lakh every month, which it had to pay as electricity bill. The LDA had identified these parks in Gomti Nagar, Kanpur Road scheme, Jankipuram, Aliganj, and various other housing schemes. The parks were to be developed and upgraded at the cost of Rs 20 crore. But as the installation of solar lights will cost Rs 15 crore more, the LDA is going to send revised budget, including Rs 15 crore, to the state government seeking its formal approval.

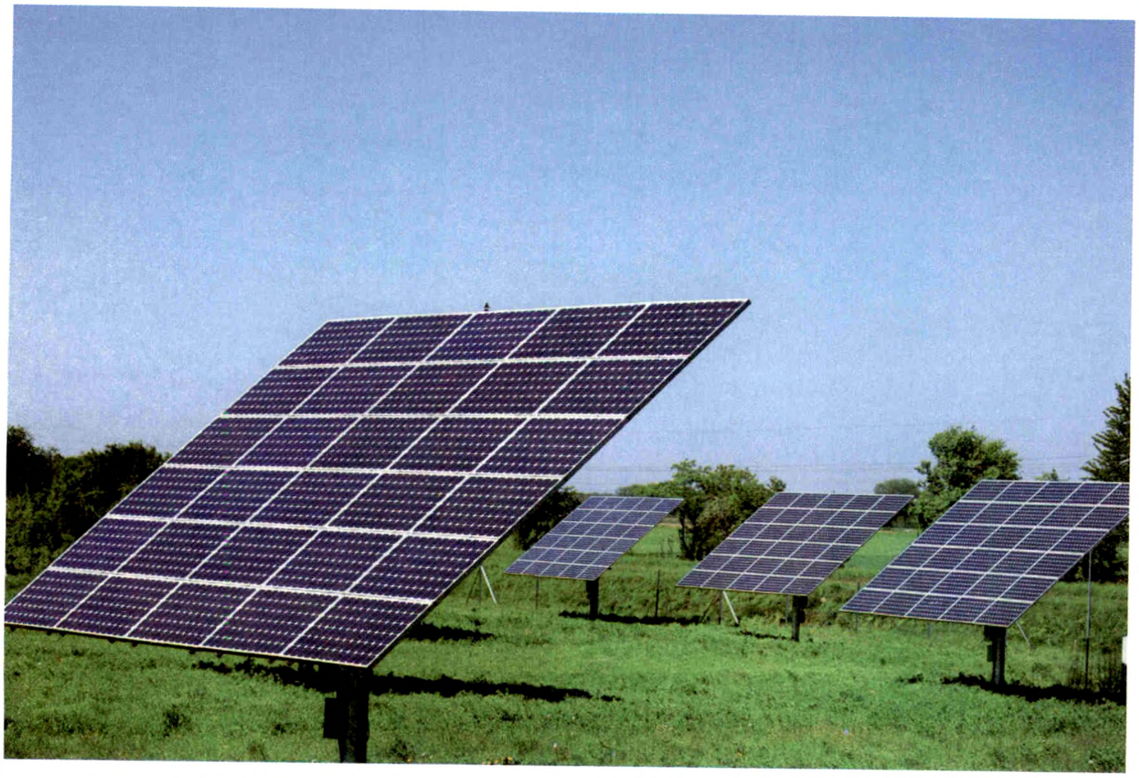
WWW.SOLARINDIAONLINE.COM

Dr. Farooq Abdullah, Union Minister for New and Renewable Energy, is the new patron of Akshay Urja

Born in 1937 in Soura on the outskirts of Srinagar, Dr Farooq Abdullah did his MBBS from the SMS Medical College, Jaipur. He has had a long and distinguished political career, having served as the Chief Minister of Jammu and Kashmir thrice and a Member of Parliament twice. He has been a member of the Committee on Defence, Member of Parliamentary Forum on Population and Public Health, and a Member of Consultative Committee of the Ministry of Civil Aviation. Dr Abdullah has been conferred the 'Dr B C Roy Award' as a medical man-cum-statesman and D Litt. (Honoris Causa) from Aligarh Muslim University.

An ardent golfer, he is keenly interested in photography, classical music, and ghazals. He is also an avid traveller.

***Akshay Urja* welcomes Dr Farooq Abdullah as its new Patron.**



Solar forecast sees industry bounce back

A new report on the SPV (solar photovoltaic) industry from the perspective of semiconductor industry participants has concluded that the rapidly changing balance between supply and demand for high-purity silicon is contributing to a rethinking of priorities in the SPV sector. The report Solar Energy: growth opportunities for the semiconductor industry comes from IC Insights and forecasts that on a megawatt basis, global installations will drop 22% this year. Meanwhile average selling prices for solar panels is expected to drop 28% as the supply constraint has evaporated and the cost of silicon is coming down significantly.

At the same time, demand for solar installations has plummeted due to the recession and credit crunch, as well as government incentive cutbacks in Europe, IC says, noting that solar panel inventories have built up, and competition has intensified for the reduced available business, driving prices down across the solar PV supply chain. However, IC Insights expects demand for solar installations to come charging back in 2010 as new government incentives in the US, Europe, and China gain traction. Installations are forecast to rise 37% to 6.7 GW, with continued growth achieving a compound annual growth rate of 25% over the 2008-2013 forecast period. The price drop of 2009, while not forecast to repeat in 2010-2013, will make solar systems more attractive in more markets even as government incentives supporting installations start to taper off starting four or five years down the road, IC Insights believes.

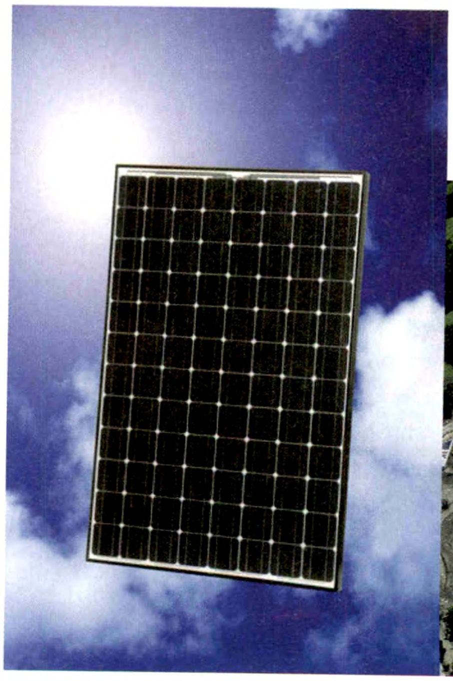
With the cost of silicon dropping, R&D investments in solar device design and manufacturing technology will back off the push to minimize silicon consumption and centre on new ways to reduce costs and boost device efficiency, the analysis says.

WWW.RENEWABLENERGYWORLD.COM

Sanyo raises solar cell efficiency to 23%

Sanyo Electric has broken its own record for the highest energy conversion efficiency in a practical size (100 cm^2 or more) of crystalline silicon solar cells, achieving an efficiency of 23% (until now 22.3%) at a research level for its proprietary HIT solar photovoltaic cells. Heterojunction with intrinsic thin layer solar cell is composed of a single thin crystalline silicon wafer sandwiched by ultra-thin amorphous silicon layers. This product provides industry-leading performance and value using state-of-the-art manufacturing techniques.

The increase in the solar cell conversion efficiency this time is



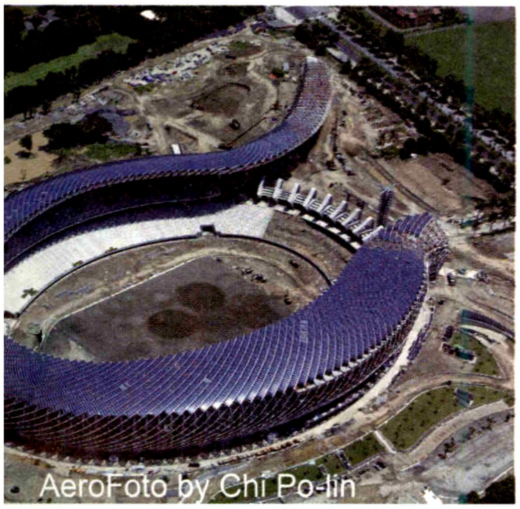
accompanied by significant advances in lowering the production cost of the photovoltaic system and the reduction in the use of raw materials such as silicon. The company has managed to improve the quality of the HIT solar cell junction through developing a technology for depositing a higher quality a-Si layer over the c-Si substrate while protecting the c-Si surface from being damaged.

The company has reduced optical absorption loss in both the a-Si layer and transparent conductive layer. As a result, the short circuit current (Isc) *8 was improved from 39.2 mA/cm^2 to 39.5 mA/cm^2. In a solar cell, generated electric current is collected by and taken out through the surface grid electrode. Sanyo has recently realized lower-resistance electrode material for use in the grid electrode and a higher-aspect ratio through improving printing technology, leading to a success in reduction of resistance loss when an electric current flows through the grid electrode. As a result, the fill factor (FF) *9 was improved from 0.791 to 0.80.

WWW.SOLARBUZZ.COM

New solar stadium in Taiwan

It is official now. Taiwan will hold the World Games 2009 in July. This international sporting event will include games like korfball, billiards, dragon boat racing, and women's tug-of-war. But why are we discussing World Games 2009 in an alternative energy spectrum? Actually, Taiwan can boast of Asia's first fully solar-powered stadium. The stadium gives a dragon-like impression if you happen to view it from the sky. In their culture, dragon is associated with good fortune. If you happen to spot the dragon scales, look carefully again. These dragon scales are actually 8844 solar panels. These solar panels are enough to meet the stadium's energy needs. The roof covers an area of 14 155 m^2. They can produce about 1.14 gigawatt hours of electricity every year. This amount of electricity is enough to power 80% of the stadium's surrounding neighborhood when it's not in use. The stadium has 3300 lights and two giant TV screens.

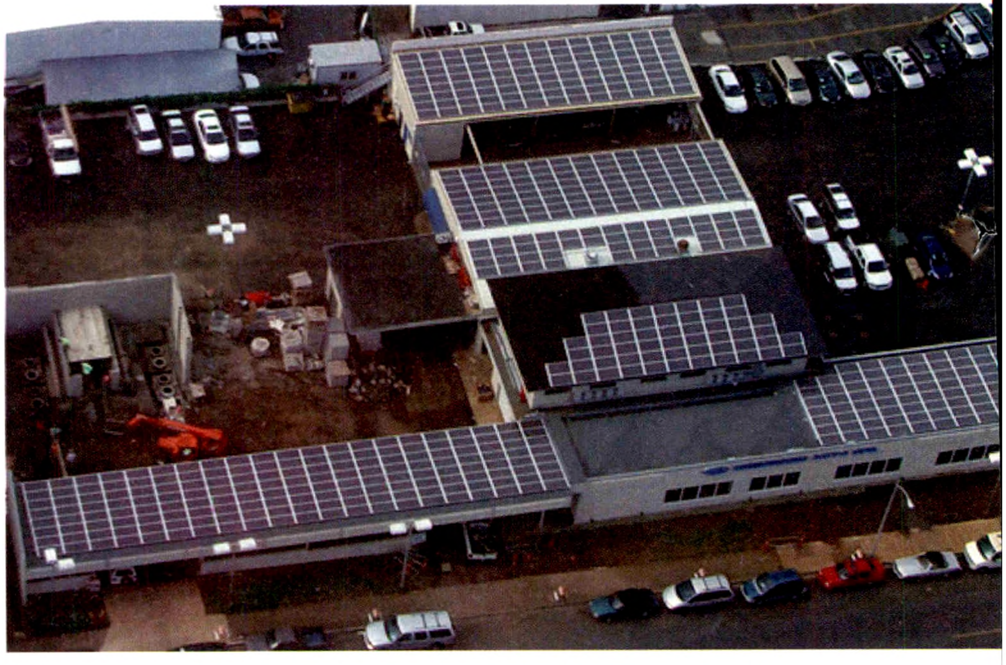


The person who is responsible to give this abstract idea a concrete form is a Japanese architect Toyo Ito. This project cost about $150 million to build and can accommodate 55 000 spectators. This stadium is situated in the city of Kaohsiung. Switzerland too has a somewhat similar high-profile Stade de Suisse that is located in Bern. It can accommodate 32 000 spectators and produce 700 000 kWh annually. Beijing National Indoor Stadium too can absorb 19 000 spectators and has 1124 solar panels. However, Taiwan till date can be proud owner of the largest solar-powered stadium in the world. Taiwanese officials claim the stadium's energy production output will save 660 tonnes of carbon dioxide each year.

This is not the whole story. The stadium's designers have also put lots of effort to curtail the environmental impact of the stadium. They utilized only those raw materials that have been procured from Taiwan and are 100% reusable. The site is surrounded by 19 hectares of open space, with about 7 hectares exclusively kept aside as integrated public green spaces, bike paths, sports parks, and even an ecological pond. To further make the entire project environment friendly, all of the plants occupying the area before construction were transplanted. The stadium will be utilized for rugby and other athletic events, including home matches for the football team after the World Games 2009 will be over.

We all know what it takes to build a new stadium. It is always a massive undertaking that consumes millions of dollars, sizable number of labourers, and huge amount of power supply while the construction is underway. It is amazing to think that it took a mere two years to finish the construction process on this unique eco-friendly stadium. In order to generate the massive amount of energy the stadium utilizes it 14 155 square metre solar roof to capture the sunrays, and the consequent power generation can power the stadium's 3300 lights and two jumbo vision screens. The test run has already been carried out, and to everybody's pleasant surprise, it merely took 6 minutes to power up the stadium's entire lighting system. So we can see that going solar on a large scale is not some impossible feat. It can be achieved if we don't limit our imaginations.

WWW.ALTERNATIVEENERGYNEWS.INFO



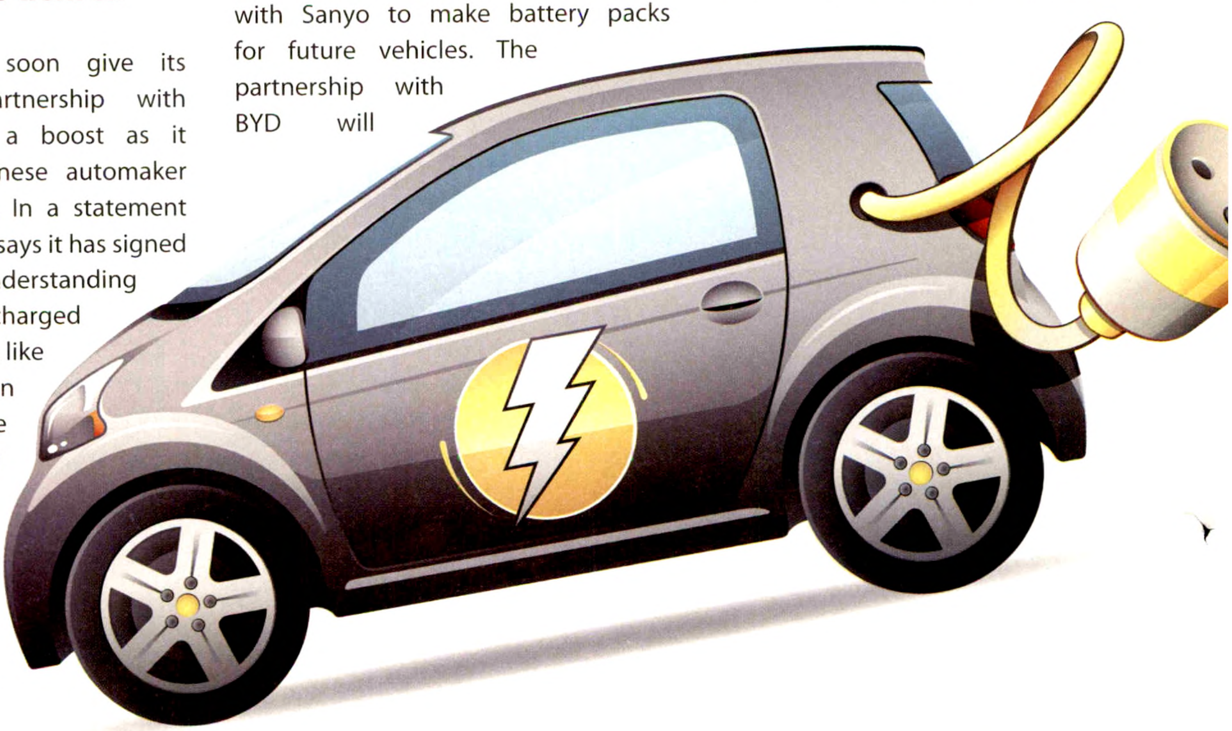
Volkswagen, BYD to work on electric cars

Volkswagen will soon give its longstanding partnership with China's automakers a boost as it cooperates with Chinese automaker BYD on electric cars. In a statement released, Volkswagen says it has signed a memorandum of understanding with BYD – a company charged to 'Build Your Dreams', like the M1 sedan shown above – effective last week. The new deal will help both companies to work towards future electric vehicles.

Interestingly, Volkswagen said in the statement that it has shown BYD an electric vehicle prototype, which could suggest the company is looking for a least-expensive assembly site for its upcoming EV, which it confirmed it would build and would show as an electric-car concept at the 2009 Frankfurt motor show.

Volkswagen says its EV effort would have to produce a vehicle with about 120 miles of range. It has also partnered with Sanyo to make battery packs for future vehicles. The partnership with BYD will explore possible electric cars, hybrid cars, and battery building, VW added in its release.

HTTP://BLOGS.THECARCONNECTION.COM



PVT solar panels generate heat and electricity at the same time

PVT Solar, manufacturer and seller of integrated SPV (solar photovoltaic) and ST (solar thermal) systems for residential and business purposes, is pioneering an ultra-efficient breed of solar panels. These panels will focus not only on incorporating better PV components, but also use the heat generated by the solar panels to power a ST system.

Standard PV systems generate electrical energy from the sun, while ST systems use it to heat something, like water, for consumption within a home. PVT Solar is aiming to marry both systems into one, since PV systems are known to release excess heat that is not used. Apart from taking waste heat and giving it an actual use, this combination would also add the benefit of making the solar panel cooler, which in turn, would make it more efficient, generating more energy. According to the company, these 'solar cogeneration panels' are three times more efficient than any other panels in the market!

PVT Solar is funded by Vinod Koshla, the founder of Sun Microsystems. According to a profile in the New York Times, what drew Mr Koshla to the company was the company's remarkable achievement in efficiency. PVT Solar is the latest company to commercialize solar cogeneration technology, and is the first to really consider deploying a system for residential use.

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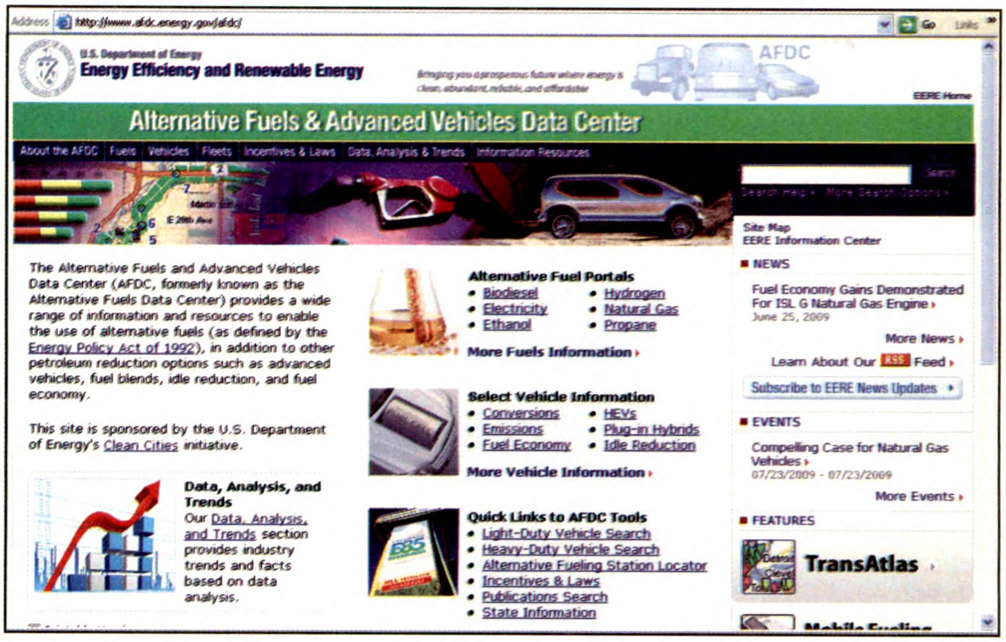
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The Alternative Fuels and Advanced Vehicles Data Center (AFDC, formerly known as the Alternative Fuels Data Center) provides a wide range of information and resources to enable the use of alternative fuels (as defined by the Energy Policy Act of 1992), in addition to other petroleum reduction options such as advanced vehicles, fuel blends, idle reduction, and fuel economy.

This site is sponsored by the U.S. Department of Energy's Clean Cities initiative.

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Our Data, Analysis, and Trends section provides industry trends and facts based on data analysis.

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TransAtlas

Mobile Fueling

Interactive map shows US alternative fuel data

The US DOE (Department of Energy) and the NREL (National Renewable Energy Lab) announced the launch of a comprehensive mapping tool to help industry and government planners implement alternative fuels and advanced vehicles. The new TransAtlas tool combines several different types of geographic data to identify areas with potential for developing advanced transportation projects. It is sponsored by DOE's 'Clean Cities' initiative, which aims to reduce petroleum consumption in the transportation sector by promoting advanced vehicle technologies and alternative fuels. This interactive mapping tool is available by visiting www.afdc.energy.gov and clicking on the TransAtlas icon.

'What is unique about this interactive website is the bringing together of so many types of alternative vehicle fuels data into one place,' said National Clean Cities Director Dennis Smith at DOE. 'Establishing a national network of fuelling stations, fuel production facilities, and transportation infrastructure is vital to the successful implementation of alternative fuel and advanced technology vehicles', he added.

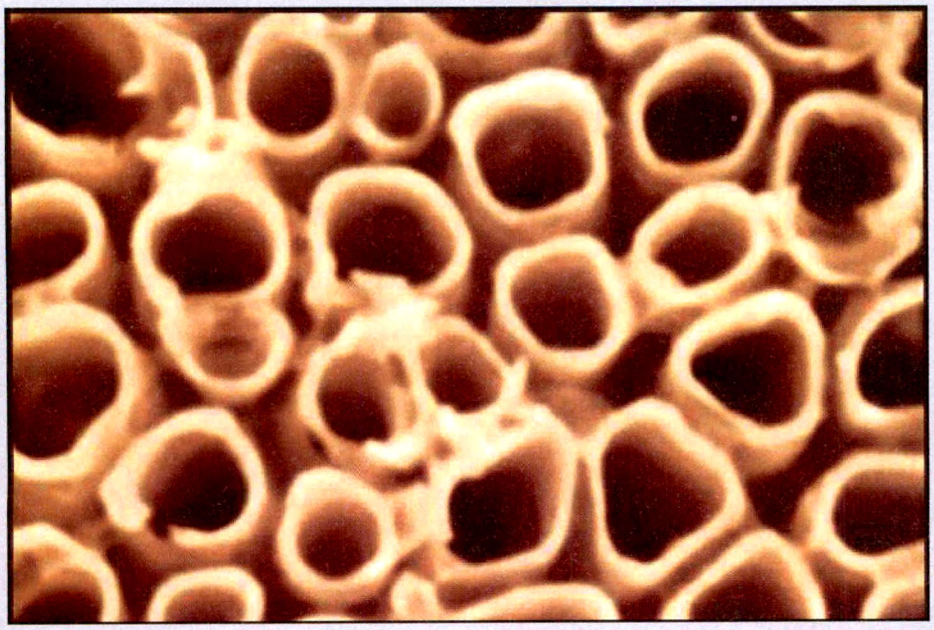
NREL employed user-friendly Google Maps to display the locations of existing and planned alternative fueling stations, concentrations of different vehicle types, alternative fuel production facilities, roads and political boundaries. The TransAtlas tool allows users to customize the information simply by checking boxes for each element. One or more types of fueling stations can be shown, including stations that dispense biodiesel, compressed or liquefied natural gas, ethanol (E85), electricity, hydrogen, and propane. Checking additional boxes adds existing ethanol production facilities and facilities under construction. To explore the site deeper, the query function can be used to select individual stations or production facilities, or those in an entire region. Querying a station shows its location, contact information, and public access status. Querying a production facility shows its location, production capacity, and feedstock type.

'The ability to drill-down and see very detailed information, including a station contact or even the production capability of an individual location, puts a wealth of information directly into the user's hands,' said Mr Smith.

The display can be further customized by using the intuitive pan and zoom functions and setting map elements to various levels of transparency. Once the display has been customized, a print-ready version can be generated.

WWW.NREL.GOV

Discovery of an unexpected boost for solar water-splitting cells



A research team from Northeastern University and the NIST (National Institute of Standards and Technology), United States, has discovered, serendipitously, that a residue of a process used to build arrays of titania nanotubes – a residue that was not even noticed before this – plays an important role in improving the performance of the nanotubes in solar cells that produce hydrogen gas from water. Their recently published results indicate that by controlling the deposition of potassium on the surface of the nanotubes, engineers can achieve significant energy savings in a promising new alternate energy system.

Titania (or titanium dioxide) is a versatile chemical compound best known as a white pigment. It is found in everything from paint to toothpastes and sunscreen lotions. Thirty-five years ago, Akira Fujishima startled the electrochemical world by demonstrating that it also functioned as a photocatalyst, producing hydrogen gas from water, electricity, and sunlight. In recent years, researchers have been exploring different ways to optimize the process and create a commercially viable technology that essentially transforms sunlight into hydrogen, a pollution-free fuel that can be stored and shipped.

Increasing the available surface area is one way to boost a catalyst's performance. Thus, a team at the Northeastern University has been studying techniques to build tightly packed arrays of titania nanotubes, which have a very high surface-to-volume ratio. They also were interested in how best to incorporate carbon into the nanotubes because carbon helps titania absorb light in the visible spectrum. Pure titania absorbs in the ultraviolet region, and much of the ultraviolet is filtered by the atmosphere.

This brought them to the NIST X-ray spectroscopy beamline at the NSLS (National Synchrotron Light Source)*. The NIST facility uses X-rays that can be precisely tuned to measure chemical bonds of specific elements, and is at least 10 times more sensitive than commonly available laboratory instruments, allowing researchers to detect elements at extremely low concentrations. While making measurements of the carbon atoms, the team noticed spectroscopic data, indicating that the titania nanotubes had small amounts of potassium ions strongly bound to the surface, evidently left by the fabrication process, which used potassium salts. This was the first time potassium has ever been observed on titania nanotubes. Previous ones were not sensitive enough to detect it.

The result was mildly interesting but became much more so when the research team compared the performance of the potassium-bearing nanotubes to similar arrays deliberately prepared without potassium. The former required only about one-third the electrical energy to produce the same amount of hydrogen as an equivalent array of potassium-free nanotubes. 'The result was so exciting', recalls Northeastern physicist Latika Menon, 'that we got sidetracked from the carbon research.' Since it has such a strong effect at nearly undetectable concentrations, Menon says, potassium probably has played an unrecognized role in many experimental water-splitting cells that use titania nanotubes because potassium hydroxide is commonly used in the cells. By controlling it, she says, hydrogen solar cell designers could use it to optimize performance.

WWW.SCIENCEDAILY.COM

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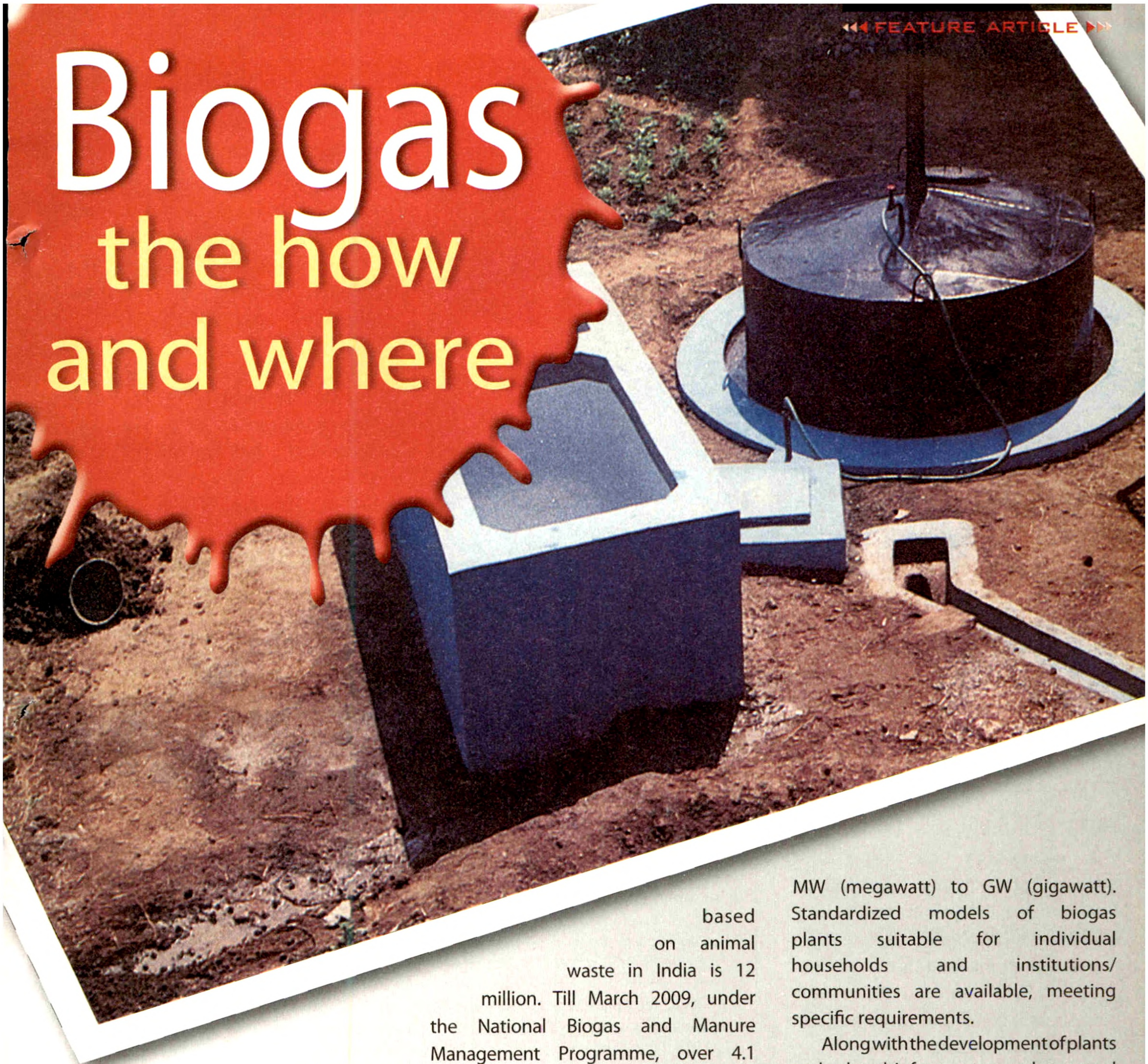
*The NSLS is part of the Department of Energy's Brookhaven National Laboratory.

Biogas
the how and where



Biogas represents an alternative source of energy, derived mainly from organic wastes. In India, the use of biogas derived from animal waste, primarily cow dung, has been promoted for over three decades now. According to the 1997 Livestock Census, the cattle population in the country is about 290 million. The estimated potential of household biogas plants based on animal waste in India is 12 million. Till March 2009, under the National Biogas and Manure Management Programme, over 4.1 million biogas plants in the capacity of 1–6 m^3 have been installed. Larger units have also been set up in many villages, farms, and cattle houses. The estimated biogas production from these plants is over 4.1 million m^3 per day, which is equivalent to a daily supply of about 2.5 million m^3 of natural gas.

These plants usually provide thermal, electrical, and mechanical power, generating electricity from MW (megawatt) to GW (gigawatt). Standardized models of biogas plants suitable for individual households and institutions/communities are available, meeting specific requirements.

Along with the development of plants and related infrastructure, a large pool of skilled manpower has been trained and deployed for plant construction and maintenance. The technology involved is anaerobic digestion, which has been successfully extended to treat industrial and urban wastes on a large scale. This holds potential as a solution to numerous environmental problems, including waste and manure handling, water pollution, and carbon dioxide emission.

Types of biogas plants

Fixed-dome type

The fixed-dome biogas plant consists of one lower segment (digester) and a hemisphere over it (gas holder). The mixing tank is connected to the digester by a 15-cm asbestos cement pipe. Through the outlet hole provided in the digester, the slurry is pushed into the outlet tank.

Floating-drum type

The floating-drum type biogas plant consists of a deep well-shaped underground digester connected by inlet and outlet pipes. A mild-steel gas storage drum, inverted over the slurry, rises and falls around a guide pipe corresponding to the accumulation and withdrawal of gas.

Bag-type

Made of rubberized nylon fabric, the bag-type biogas plant is a portable unit, which can be conveniently placed at any location. The appropriate model is selected on the basis of technical requirements such as location, distance between kitchen and cattle shed, availability of dung and water, and preferences of the beneficiaries.

Table 1 lists the model household biogas plants and appliances approved for promotion under the National Biogas Programme.

Standard capacity

For family-type biogas plants, approved models are available for 1–6 m^3 and 1–10 m^3 capacities for fixed-dome and floating-drum plants, respectively. The commonly used capacities of these models are 1–4 m^3 (Table 2).

Cost

The cost of installation varies according to the model and size of the plant. The average estimated cost of the most popular Deenbandhu model is given in Table 3. The cost of a biogas plant

Table 1 Model household biogas plants/appliances approved for promotion under the National Biogas Programme

Model - Design guidelines	*Contact address*
I. Fixed-dome biogas plant	
1) Deenbandhu model with brick masonry Code practices (second revision) IS 9478:1989 of the BIS, New Delhi	MNRE State Implementing Agencies Web site: mnre.nic.in
2) Deenbandhu ferrocement model with in situ technique	MNRE State Implementing Agencies Web site: mnre.nic.in
3) Pre-fabricated RCC fixed-dome model	MNRE State Implementing Agencies Web site: mnre.nic.in
II. Floating drum biogas plant	
1) KVIC floating metal drum type Code practices (second revision) IS 9478:1989 of the BIS, New Delhi	MNRE State Implementing Agencies Web site: mnre.nic.in
2) KVIC type plant with ferrocement Code of practices IS 12986:1990 of BIS, New Delhi	MNRE State Implementing Agencies Web site: mnre.nic.in Khadi and Village Industries Commission (KVIC), Mumbai
III. Pragati model Code of practices (second revision) IS 9478:1989 of the BIS, New Delhi	United socio-economic Development and Research Programme (UNDARP) Pune
IV. Bag-type biogas plant Bag type biogas plant – Flexi model	Swastik House, Khadki Pune – 411 003 Maharashtra
V. Appliances ISI marked (BIS Code IS-8749:1998) Burners with minimum 55% thermal efficiency	See Box No. 1 for details

Table 2 The average estimated cost of the most popular Deenbandhu model	
Plant capacity	*Cost per plant (in rupees)*
1 m³	7000
2 m³	9000
3 m³	10 500
4 m³	12 500

increases by about 30% in hilly areas and by 50%-60% in the north-eastern region of the country.

Training

Construction of biogas plants is a skilled job. Hence, the scheme has a provision of providing training to the masons and trainers for construction and maintainance of biogas plants. A total number of 11 Development and Training centres have been setup in different R&D Institute/University to tackle trainings for masons and users. This also provides opportunity for employment to rural people.

Financial incentives

Under the National Biogas Programme, central subsidy is available to users of different categories and areas for setting up biogas plants (Table 3).

Provision of loans

The RBI (Reserve Bank of India) and NABARD (National Bank for Agriculture and Rural Development) support the biogas programme. Detailed guidelines are available with both commercial and cooperative banks for financing family-type biogas plants under the Agricultural Priority area. NABARD provided automatic refinancing facility to commercial banks for loan amounts disbursed for biogas plants.

Table 3 National Biogas Programme: central subsidy for different categories and areas for setting up biogas plants (2009/10)

Category/area	Central subsidy per plant
North-eastern states and Sikkim (except plain areas of Assam)	Rs 11 700
Plain areas of Assam	Rs 9000
Jammu and Kashmir, Himachal Pradesh, Uttaranchal (excluding Terai region), Nilgiris of Tamil Nadu, Sadar Kurseong and Kalimpong sub-divisions of Darjeeling, Sunderbans, and Andaman and Nicobar Islands	Rs 4500 (restricted to Rs 3500 for 1 m³ fixed dome type)
Scheduled caste, scheduled tribe, desert districts, small and marginal farmers, landless labourers, Terai region of Uttaranchal, Western Ghats, and other notified hilly areas	Rs 3500 (restricted to Rs 2800 for 1 m³ fixed dome type)
All others	Rs 2700 (restricted to Rs 2100 for 1 m³ fixed dome type)

Repair and servicing facility

The government pays a job fee of Rs 800 per biogas plant constructed on turnkey basis with three years' warranty for trouble-free functioning of the plant in north-eastern states, Sikkim, Jammu and Kashmir, Himachal Pradesh, Uttaranchal, hilly districts, and islands. In other regions, it is Rs 700 per plant. Financial support limited to 50% of the rate of central subsidy is also provided for repair and revival of family-type biogas plants that are at least five years old and have developed structural defects thereafter.

Courtesy: MNRE, Government of India

Manufacturers of biogas burners

M/s Sunflame Industries (P) Ltd
Shed No. 2, Plot No. 58
P O Amar Nagar, Faridabad – 121 003

M/s Batra Investments Pvt. Ltd
14/1, Mathura Road
P O Amarnagar
Faridabad – 121 003

M/s Gas and Chemical Industries (P) Ltd
14/1 Mathura Road
Faridabad - 121 003

M/s Baroda Appliances
886/A, GIDC Makarpura
Baroda - 10

M/s Sweet Home Appliances Pvt. Ltd
3-E/16, BPNIT
Faridabad – 121 001

M/s Tulsi Domestic Appliances
30-A, Old Industrial Area
Alwar - 301 001

M/s Associated Engineering Works
Tanuku - 534 211
Andhra Pradesh

M/s Mitaso Appliances Ltd
Plot No. 63, Sec. 6
Faridabad – 121 006

M/s Agriculture Associates
Station Road
Alwar (Rajasthan)

M/s Malhotra Engineering Company (P) Ltd
572-B, Nangloi
New Delhi – 110 041

M/s Rupak Enterprises
1/46 Vishwas Nagar, Shahdra
New Delhi –110 032

Bhawna Industries
8-A, Industrial Development Colony
Kunjpura Road, Karnal – 132 001, Haryana

M/s Mech-Ci-Co.
1-7, GIDC Industrial Township
Vatwa, Ahmedabad – 382 445

Inter Gas Appliances Pvt. Ltd
C-113, Sector-2
Noida – 201 301, Uttar Pradesh

Akshay Urja bids adieu to Mr Vilas Muttemwar, former Minister for New and Renewable Energy

Shri Vilas Muttemwar represents Nagpur Lokshabha constituency of Maharashtra and has been re-elected 7th time as a Member of Parliament of the 15th Lok Sabha in May 2009. Shri Vilas Muttemwar completed his full tenure of five years as Minister for New and Renewable Energy. During his tenure the renewable energy sector took a leap with installation of over 9500 MW of renewable powers in the country, and the massive installation of solar water heating systems, solar lighting systems, family-size biogas plants, and a number of other renewable energy systems. The major initiatives taken by him for popularizing renewable energy among the common people include the Akshay Urja magazine, Rajiv Gandhi Akshay Urja Diwas, Renewable Energy Clubs, District Advisory Committees, and so on.

Akshay Urja Team wishes him success in all his future endeavours.

Inviting articles for Akshay Urja

Akshay Urja publishes news, articles, research papers, case studies, success stories, and write-ups on RE. Readers are invited to send material with original photographs and statistical data. The photographs should be provided on hard copy or as high resolution (minimum 300 DPI) files on a CD. *Akshay Urja* will pay suitable honorarium for each published article of about 1500 words and above to the authors. The publication material in two copies, along with a soft copy on CD/floppy/ e-mail may be sent to

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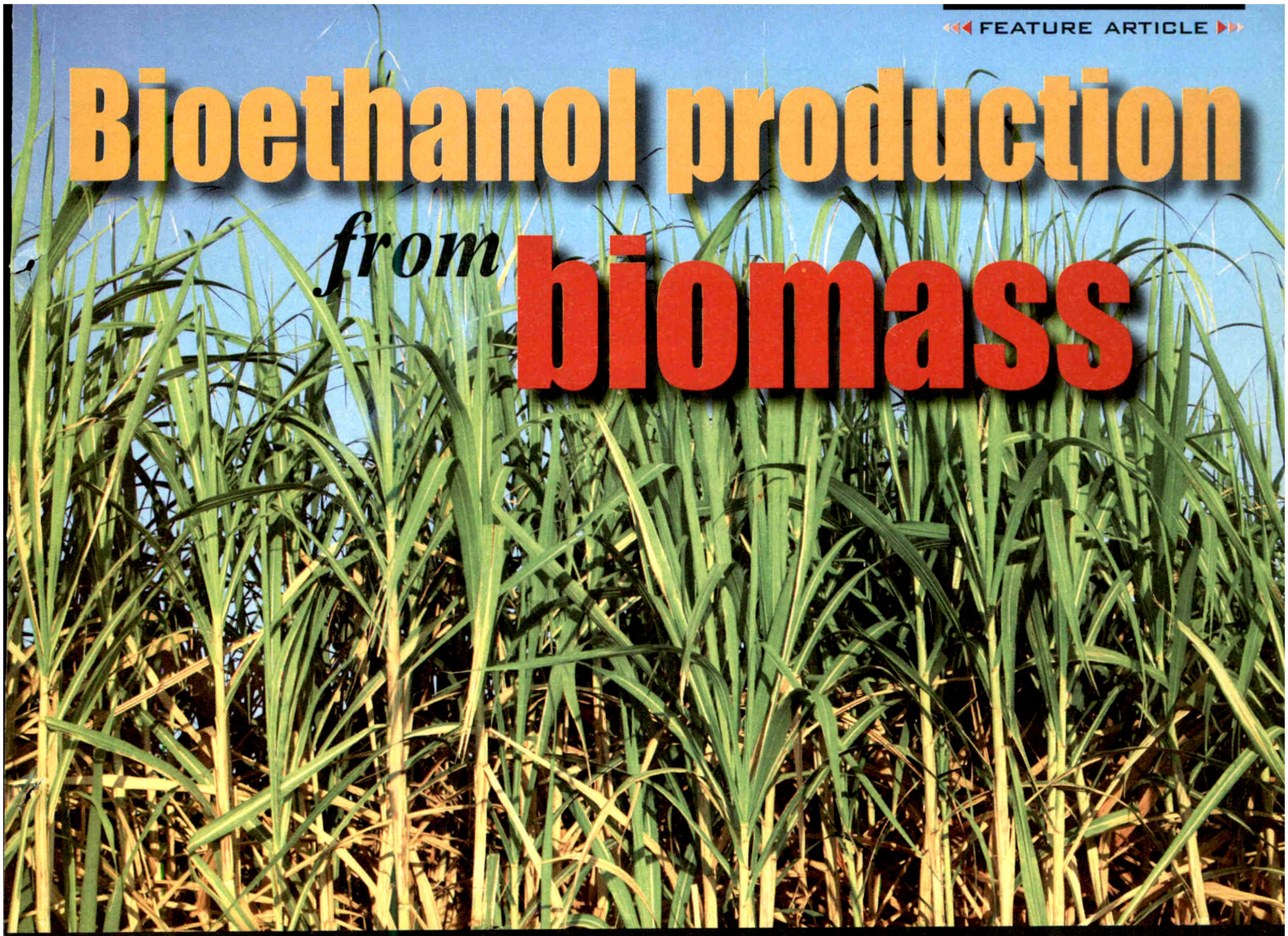
E-mail aktripathi@nic.in

Bioethanol production *from* biomass



SACHIN KUMAR[1,2], PRATIBHA DHEERAN[1] AND
DILIP K ADHIKARI[1]

Lignocellulosic biomass is the most abundant renewable resource on earth. Lignocellulosic materials, including wood, grass, forest residues, agricultural residues, pulp and paper mill wastes, and municipal solid wastes can be used for bioethanol production. Among these resources, agricultural residues, such as sugarcane bagasse, dominate in terms of tonnage and can serve as feedstock. Sugarcane bagasse is plentiful in tropical and subtropical regions such as Brazil, India, Thailand, Hawaii, and the southern USA. Other lignocellulosic feedstocks include agricultural residues such as corncob, corn stover, wheat, and rice straw; industrial residue such as pulp and paper processing waste; and energy crops such as switch grass.

Lignocellulosic materials are comprised of lignin, hemicellulose, and cellulose in varying proportions. The general composition of lignocellulosic biomass is cellulose (35%–50%), hemicellulose (20%–35%), polyphenolic lignin (10%–25%) and other extractable components. The utilization of both cellulose and hemicellulosic monosachharides like hexose and pentose present in a typical lignocellulosic biomass hydrolysate (composition of various lignocellulosic biomass is shown in Table 1) is essential for the economical production of ethanol. Therefore, microorganisms that are able to ferment both glucose and xylose are most desirable for an efficient bioconversion of biomass to

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Table 1 Composition of various lignocellulosic raw materials

Raw materials	*Glucose*	*Mannose*	*Galactose*	*Xylose*	*Arabinose*
Corn stover	39	0.3	0.8	14.8	3.2
Wheat straw	36.6	0.8	2.4	19.2	2.4
Rice straw	41	1.8	0.4	14.8	4.5
Sugarcane bagasse	38.1	--	1.1	23.3	2.5
Rice hulls	38.1	3.0	0.1	14.0	2.6

ethanol. The bioethanol production from lignocellulosic biomass requires two essential steps: saccharification of lignocellulosic biomass to fermentable sugars and fermentation of sugars to ethanol.

Worldwide, bioethanol is currently produced by fermentation of monomeric sugars by mesophiles, which ferment the sugars at 25–37 °C. These mesophiles have certain limitations in fermenting pentose sugars produced from lignocellulosic biomass. However, the thermophiles have certain advantages over mesophiles, which could be exploited for ethanol production. Solvent tolerance, energy savings through reduced cooling costs, higher saccharification and fermentation rates, continuous ethanol removal, and the reduced risk of contamination have stimulated a search for thermophilic or thermotolerant yeasts. Less energy is required for mixing and product recovery in thermophilic fermentations because of lower viscosity, surface tension, higher vapour pressure, and increased solubility of organic compounds.

This article describes the saccharification of sugarcane bagasse by acid treatment followed by sugar recovery from the hydrolysate by ion exchange chromatography and fermentation of sugars in batch and continuous mode with recycle of thermophilic yeast, *Klyuveromyces sp. IIPE453* in the temperature range of 50 °C.

Materials and methods

Microorganisms and culture conditions

The strain used for ethanol production, *Kluyveromyces sp. IIPE453*, was grown in salt medium containing 0.15 g/l (gram per litre) di-sodium hydrogen ortho phosphate, 0.15 g/l potassium di-hydrogen ortho phosphate, 2.0 g/l ammonium sulphate, 1.0 g/l yeast extract, and 10 g/l glucose with pH 5.5 at 45 °C. Fermentation was carried out in a medium prepared in hydrolysate containing 0.15 g/l di-sodium hydrogen ortho phosphate, 0.15 g/l potassium di-hydrogen ortho phosphate, 1.0 g/l ammonium sulphate, and 1.0 g/l yeast extract with pH 5.0 at 45 to 60 °C in batch process and continuous process with recycling the cells.

Fermentation conditions

Batch fermentation process

Batch fermentation of sugarcane bagasse hydrolysate and cassava starch hydrolysate was performed in 2 litre Bioflow-110 bioreactor by free cells of *Kluyveromyces sp. IIPE453* in batch mode. The temperature and agitation were controlled at 50 °C and 200 rpm respectively.

Continuous fermentation process with recycling the cells

Continuous fermentation was performed in 2 litre Bioflow-110 bioreactor by using sugarcane bagasse hydrolysate solution containing glucose and xylose sugars. The hydolysate solution, supplemented with inorganic salts, was fermented using previously

Screening test for ther-moamylase

Table 2 Sugars and furfural (percentage of bagasse) recovered in first stage hydrolysis at different acid concentrations

Acid concentration (%) (w/w)	*Solid to liquid ratio*	*Xylose(%)*	*Glucose (%)*	*Furfural (%)*
2	1:10	9.2	0.6	0.12
4	1:8	13.6	0.9	0.16
6	1:8.8	19.6	1.4	0.23
8	1:8.3	23.1	4.4	0.31
	1:5.2	25	4.6	0.41
	1:4.2	26.14	4.6	0.63
10	1:8.4	25	5.8	0.95

grown cells of *Kluyveromyces sp. IIPE453*. The air/N_2 flow in proper ratio was controlled in the bioreactor for in situ recovery of ethanol. The process was performed at different dilution rates, cell mass concentration, and temperatures. The pH and agitation were controlled at 5 and 250 rpm, respectively.

Hydrolysis of sugarcane bagasse

The sugarcane bagasse powder was collected from sugar mill. It was hydrolysed by sulphuric acid treatment in two stages. In the first stage hydrolysis, the sugarcane bagasse was soaked into 2%–10% w/w sulphuric acid with a solid-to-liquid ratio of 1:10 to 1:4.2. The temperature in the digester was maintained at 100 °C for an hour and agitation in the reactor was maintained 1000 rpm. The aqueous phase was separated from the residual bagasse followed by its washing to collect xylose-rich hydrolysate-rich stream.

In second stage hydrolysis 18%–65% w/w sulphuric acid was added to residual bagasse taken from first stage hydrolysis. The temperature in the digester was maintained at 80 °C for 1 hour and agitation was maintained 1000 rpm. The aqueous phase was separated from the residual bagasse followed by its washing to collect glucose rich hydrolysate rich stream.

Hydrolysis of starch biomass

Hydrolysis of different starch biomass like soluble starch, cassava, tapioca, sweet sorghum, and maize was performed in 1 litre flasks containing 5% starch biomass in 200 ml 0.05 M acetate buffer (pH 5.0) and 100 ml crude enzyme (5.29 mg/ml). All the flasks were incubated at 80 °C and monitored at an interval of 2 hours until the total starch was hydrolysed.

Recovery of sugars from hydrolysate

The sugars from the bagasse hydrolysate were recovered by ion exchange chromatography using strong anion and weak anion resins in the ratio of 5:1 to 1:1. A glass column with 100 cm length and 3 cm diameter was packed with 700 g resins. The bagasse hydrolysates obtained in the first stage of hydrolysis contained sugar concentration of 35 g/l and sulphuric acid concentration of 60 g/l. In the second stage of hydrolysis, it contained sugar concentration of 80 g/l and sulphuric acid concentration of 200 g/l. The hydrolysate was passed through the column with flow rate ranging from 4 to 17 ml/min. The acid was retained in the column and sugars were eluted through the column. The column was regenerated with water to recover the acid and the acid solution was recycled back for hydrolysis of fresh sugarcane bagasse.

Analytical methods

Reducing sugars in media and fermented broth were determined by DNS (di-nitrosalicylic acid) method. Ethanol was determined by using gas chromatography using a Chemito 8600 Refinery Gas Analyser with a 4-m-long and 1/8 diameter Porapack column with Chemosorb 80/60. Sample was injected at 120 °C, and the oven temperature and flame ionization detector temperature was 150 °C and 200 °C, respectively, using helium as a carrier gas. Ethanol was also determined by colorimetry method. Furfural was measured by Double Beam UV-VIS Spectrophotometer 2600 at 277nm.

Results and discussion

Hydrolysis of sugarcane bagasse

In first stage hydrolysis, sulphuric acid was used at different concentrations (2% w/w to 10% w/w) and different solid-to-liquid ratios. The temperature was maintained at 100 °C for 1 hour. The hydrolysate was separated from the residual bagasse and sugars and furfural in hydrolysate were estimated. The maximum 26.14% xylose and 4.6% glucose (47% sugars of total cellulose and hemicellulose present in the sugarcane bagasse) was obtained at 8% w/w acid concentration and at 1:4.2 solid-to-liquid ratio, as shown in Table 2.

In second stage hydrolysis 6%–18% glucose and 2.5%–4.64% xylose were obtained, as shown in Table 3. The maximum 33% sugars of total cellulose and hemicellulose present in sugarcane bagasse was achieved at 65% w/w sulphuric acid concentration when the digester temperature was maintained at 80 °C for 1 hour followed by diluting the acid to 20% w/w and again maintained the temperature 100 °C for 30 minutes and agitation was maintained 1000 rpm. The furfural concentration was negligible.

Table 3 Sugars and furfural (percentage of bagasse) recovered by second hydrolysis at different acid concentrations

Acid concentration (%) (w/w)	*Acid (%) (w/w) (acid/sugar)*	*Glucose (%)*	*Xylose (%)*	*Furfural (%)*
18	50	6	3.5	0.21
26.4	75	9.7	2.5	0.16
33.8	100	14.5	4.64	0.14
65	125	18	3.34	0.11

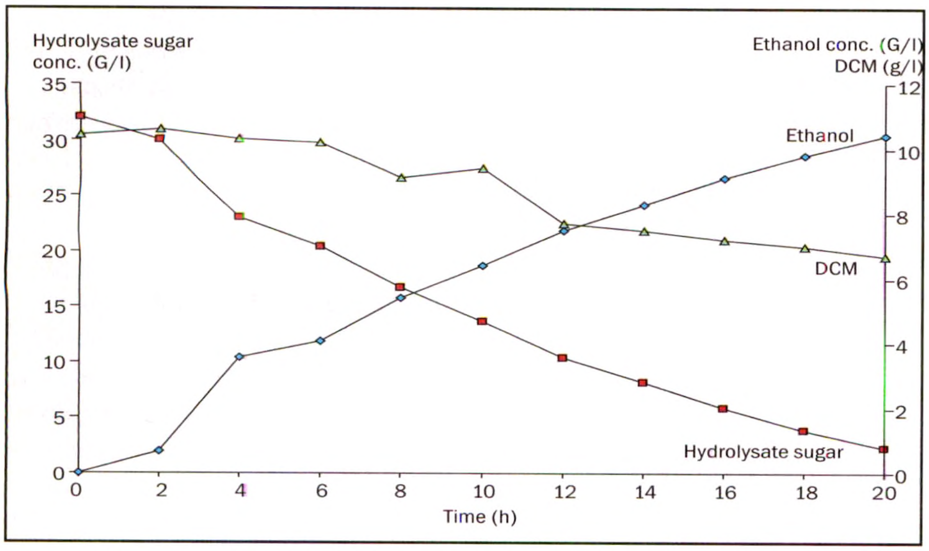


Figure 1 Ethanol production in batch mode by *Klyuveromyces sp. IIPE453* in sugarcane bagasse hydrolysate at 50 °C

Recovery of sugars from hydrolysate

The sugarcane hydrolysate, containing fermentable sugars and sulphuric acid, was passed through the column containing ion exchange resins. About 95%–100% acid-free sugars were recovered, with strong anion and weak anion mixture in the ratio of 5:2 and flow rate 17 ml/min. Ninety five per cent acid was recovered in regeneration of the column. The recovered acid was recycled for further hydrolysis of fresh sugarcane bagasse.

Ethanol fermentation from sugarcane bagasse hydrolysate

Batch fermentation process

The concentration of thermophilic yeast, *Kluyveromyces sp. IIPE453,* was kept at about 10 g/l. Total sugar was consumed within 20 hours as shown in Figure 1. The final ethanol concentration in broth was 10.2 g/l with ethanol yield of 35% and productivity of 0.52 g/l/h.

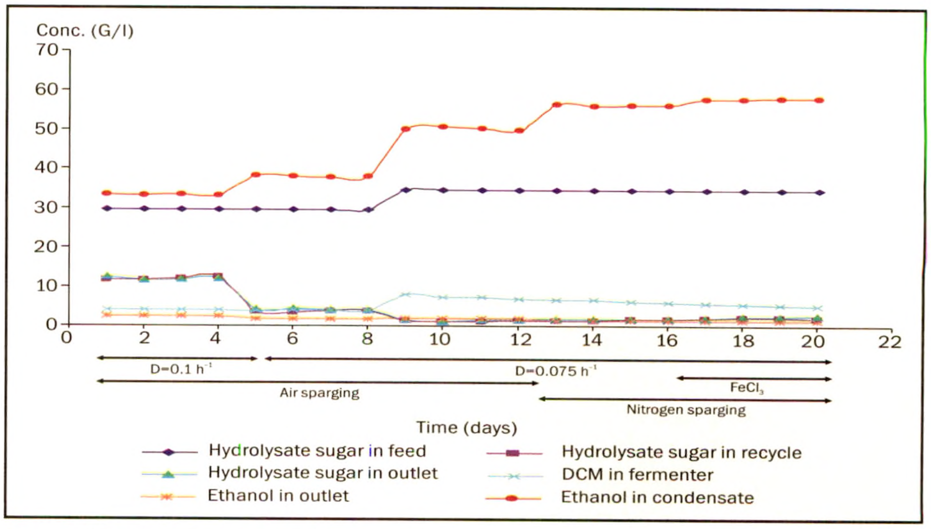


Figure 2 Continuous fermentation with cell recycle at 50 °C and air/N_2 stripping in sugarcane bagasse hydrolysate by *Kluyveromyces sp. IIPE453*

Continuous fermentation process with recycling the cells

The sugarcane bagasse was fed into the bioreactor with a dilution rate of 0.075/h and 0.1/h at 45–60 °C. The highest ethanol yield and productivity of 42% and 2.3 g/l/h, respectively, was obtained at 45 °C and 0.1/h. At 50 °C, air/N_2 was passed through the bioreactor for in situ recovery of ethanol at different conditions as shown in Figure 2. The overall ethanol yield on the basis of total fermentable sugars present in hydrolysate in continuous fermentation with cell recycle at 50 °C was 35%–38% with ethanol productivity of 0.216–1.86 g/l/h. Almost 90% of ethanol was recovered during fermentation on stripping by air/N_2 and five times concentrated ethanol was obtained as compared to ethanol in fermented broth.

Simultaneous liquification and saccharification of starch biomass

Different starchy biomass like soluble starch, cassava starch, tapioca starch, sweet sorghum, and maize were hydrolysed by thermoamylase isolated from *Geobacillus sp. IIPTN* at 80 °C as shown in Figure 3. The total starch for each substrate was hydrolysed in

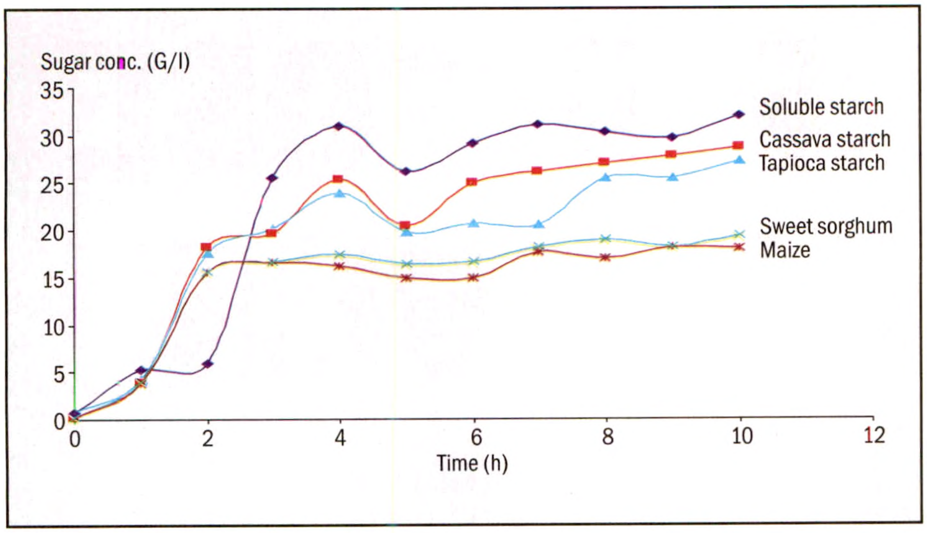


Figure 3 Enzyme hydrolysis of starch base biomass at 80 °C by thermoamylase produced by *Geobacillus sp. IIPTN*

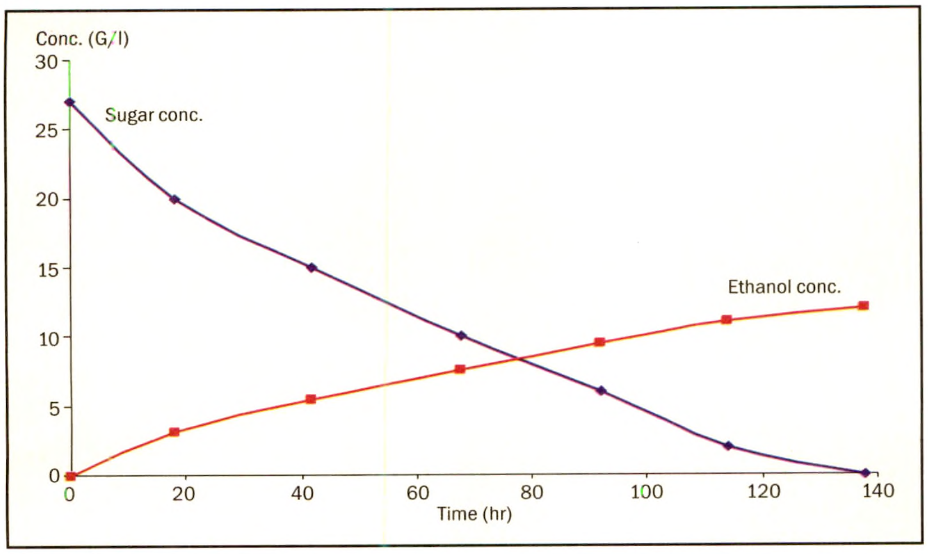


Figure 4 Ethanol production in batch mode by free cells of *IIPE453* from cassava hydrolysate.

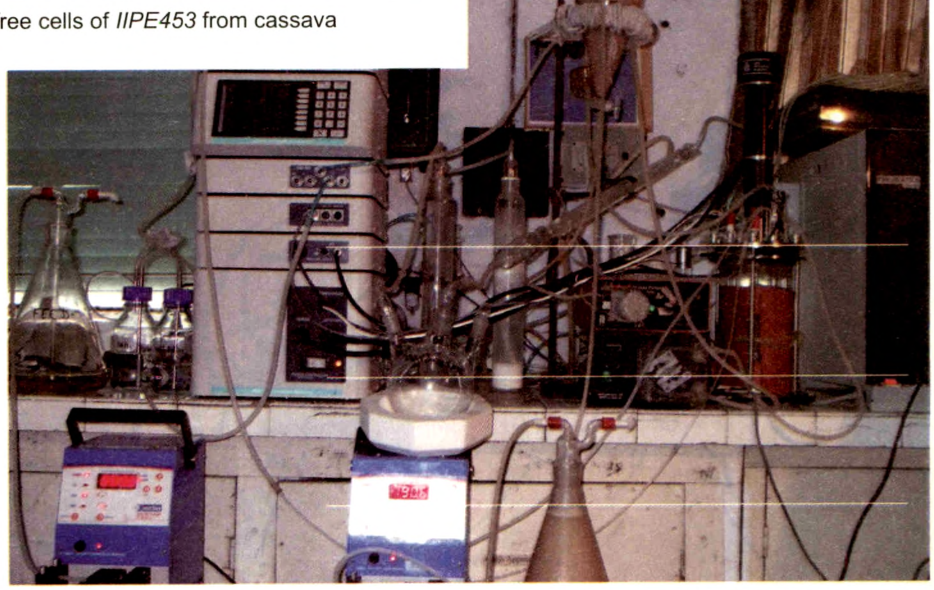
10 hours. The sugar yield on tapioca and sweet sorghum were obtained at 81.7% and 58%, respectively.

Ethanol production from cassava hydrolysate

Fermentation was carried out with cassava hydrolysate in batch mode by free cells of *Kluyveromyces sp. IIPE453* as shown in Figure 4. The total sugar in hydrolysate was consumed in 138 hours with productivity of 0.09g/l/h. The ethanol yield was obtained at 45% on the basis of fermentable sugars and the overall ethanol yield on dry cassava basis was 33%. The dry cell mass was almost constant through out the fermentation.

Conclusion

The overall yield of fermentable sugars in acid treatment was 65%–80% (w/w) of total cellulose and hemicellulose present in sugarcane bagasse under different operating conditions. The overall ethanol yield on the basis of total fermentable sugars present in hydrolysate was obtained 35% in batch process with ethanol productivity of 0.52 g/l/h at 50 °C. The overall ethanol yield on the basis of total fermentable sugars present in hydrolysate in continuous fermentation with recycling the cells at 50 °C was 35%–38% with ethanol productivity of 0.216–1.86 g/l/h. Almost 90% of ethanol was recovered during fermentation on stripping by air/N_2 and five times concentrated ethanol was than ethanol in broth. The thermoamylase was found very effective for hydrolysing different types of starch biomass with a considerable yield at high temperature.



MULTIPURPOSE SOLAR OVEN

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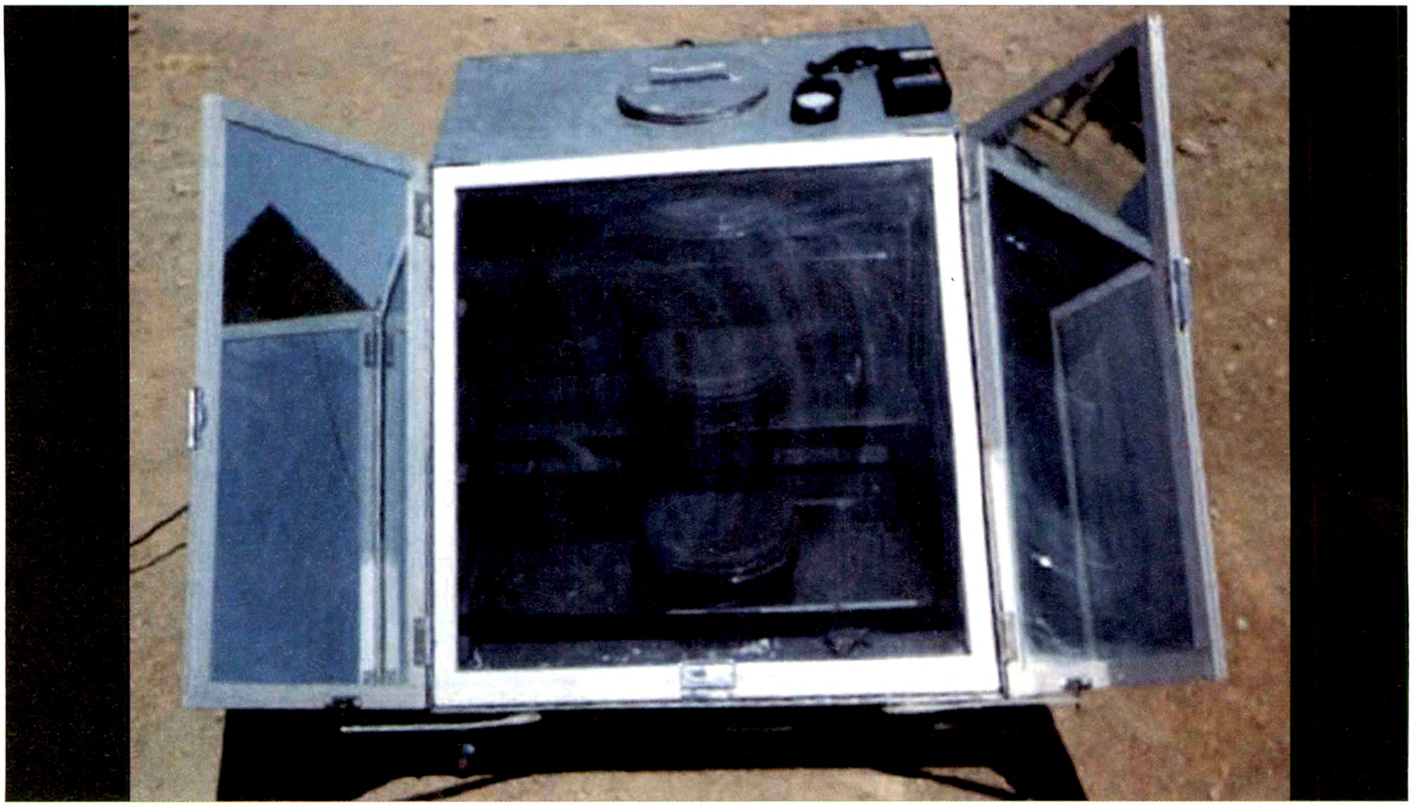
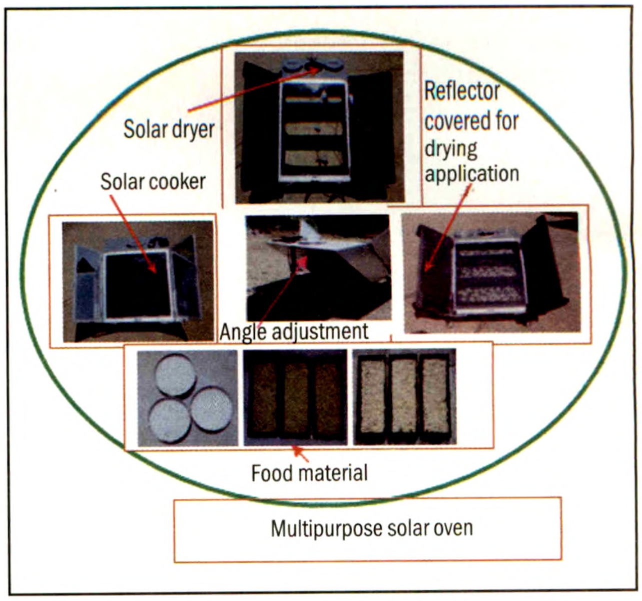
Department of Renewable Energy Sources, Maharana Pratap University of Agriculture and Technology, Udaipur – 313 001



Introduction

Solar drying and cooking are a feasible proposition in most parts of India where solar radiation is quite abundant. India receives on an average of 5 kWh/m^2/day for about 300 days per year. This energy can be utilized for various thermal applications, including drying and cooking. Solar energy appliances are employed for various uses for single operation and they remain idle when not in use. If the solar appliances are developed to perform more than one function, their versatility and reliability can be increased without reducing the quality of the products or polluting the environment. Keeping this in view, a multipurpose solar oven has been designed, developed, and tested at the Department of Renewable Energy Sources, College of Technology and Engineering in Udaipur, Rajasthan. This oven is capable of cooking food and drying food products and vegetables for meeting the requirement of about 5–6 people.



System description

This solar oven is based on hotbox principle and has two reflectors. It consists of a collector unit with a net effective area of 0.36 m^2 as shown in Figures 1 and 2. It is fundamentally based on two-process—hotbox principle through the application of solar energy and natural circulation of dried air from dryer. It consists of a closed chamber (front glazing), black metallic absorber, insulation, drying chamber, trays, reflectors, and inlet/outlet openings with lids. It was designed and fabricated at the Department of Renewable Energy Sources at CTAE, Udaipur, for drying and cooking. Three plenum chambers of sizes 350 mm × 600 mm × 140 mm; 350 mm × 600 mm × 160 mm; and 350 mm × 600 mm × 50 mm are provided below the drying tray for air circulation. The chambers are also painted dull black from the outside to receive solar insolation. Three perforated wire mesh trays of size 560 mm × 290 mm are provided for supporting the material to be dried. The inlet–outlet openings are provided with lids for airflow, which can be opened and closed according to need. Food products are kept in the trays for drying and air circulation is maintained by the openings provided at the top and the bottom. Two reflectors of size 350 mm × 600 mm are hinged at either side of the box for increasing the temperature inside chamber. While using the unit as cooker, if the openings are closed with the help of lids and the whole device becomes airtight. In this condition, the food products kept in the container inside the chamber can be easily cooked. Castor wheels are provided for the easy movement of the unit. It is installed facing the south direction with an inclination of 40 °C from the horizontal.

Result and discussion

The multipurpose cook stove was tested extensively as dryer and cooker by measuring the stagnation air temperature in the chamber. The performance rating of the solar cooker was carried out in accordance with IS 13429(part3):1992 (2). Corresponding figures of merit Figure 1 and 2 with and without heat-up conditions were also measured.

The solar hotbox was also tested for drying of rewetted maize. Drying of rewetted grains is required for removing their husks to make various products in rural areas. The time required to dry up to certain moisture content level was also measured. The stagnation temperature in multipurpose cook stove is more when the side reflector is used for both drying as well as cooking.

The results of the experiment carried out on drying and cooking of food materials are presented in Tables 1 to 3.

Solar insolation

The solar insolation recorded during drying process is shown in Table 1. The solar insolation ranged from a minimum of 220 W/m^2 to a maximum of 723 W/m^2. The maximum solar insolation of 723 W/m^2 was recorded at 1p.m. of the day. This is due to higher incidence of solar radiation at noon.

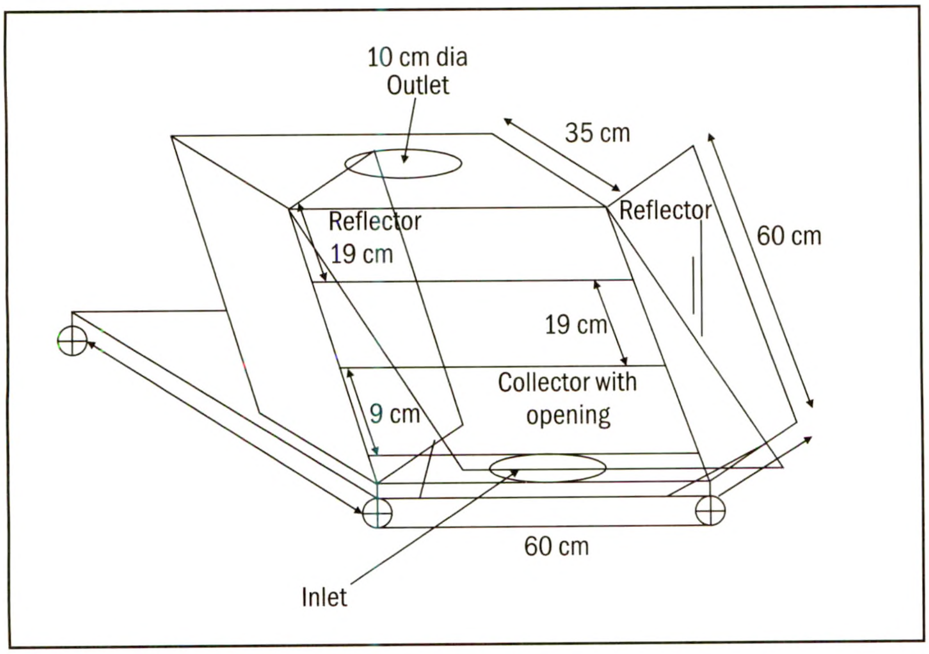


Diagram of a multi-purpose solar oven

Table 1 Thermal performance of drying unit in solar oven without reflector during winter in no load condition

Time (hrs)	Ambient temperature (°C)	Lower tray temperature (°C)	Middle tray temperature (°C)	Upper tray temperature (°C)	Outlet temperature (°C)	Insolation (W/m^2)
10:00	25	35.33	33	35	32	534
10:30	25.33	44.43	46	42	45	582
11:00	25.66	47.66	52.66	56	54.66	622.6
11:30	26.66	48.5	54.33	56.66	56.66	626.66
12:00	28	49.33	55.33	57	54.33	656.33
12:30	29	49.80	57.33	57.66	54.66	709.66
13:00	29.33	48.66	57	57.33	55	722.66
13:30	29.66	47	56	57.33	57.33	716.3
14:00	30.33	48	55.66	58	56.33	655
14:30	30. 66	48	54.66	58	54.66	617
15:00	29.66	46	53	57	52	586
15:30	29.66	43.66	47.66	53.66	50	529.33
16:00	29.33	37	45.66	49.66	47.33	427.33
16:30	28	33.66	41.66	43.66	42.33	319.33
17:00	26.66	31	33.33	33.66	30.66	220

Drying temperature

The ambient temperature and the temperature recorded inside the multi-rack hot box at three tray levels are presented in Table 2. The ambient temperature during drying period varied from a minimum of 25–33.66 °C to a maximum of 33.5 °C, and the corresponding temperatures attended inside the solar oven were to 35 °C and 58 °C respectively. The maximum temperature of 58 °C was recorded at 2 p.m. of the day at the level of tray 2; the temperature of 31 °C at the bottom tray was the lowest, though it tended to increase in upper trays. The maximum temperature of 58 °C was obtained in the uppermost tray.

Table 2 Drying of maize in solar oven in winter

Time	Lower MC	Middle MC (w.b.)	Upper MC (w.b.)
0	33.98	33.98	33.98
60	20.21	20.85	21
120	14.72	15.1	15.45
180	11.24	11.75	12.2
240	9.26	9.9	10.02
300	7.24	7.55	7.69
360	7.14	7.32	7.41
420	7.06	7.14	7.2

Cooking Temperature

The increase in the stagnation temperature with reflector in cook stove is shown in Table 1. The increase in stagnation temperatures without mirror reflector in solar hot box is shown in Table 3. The maximum stagnation temperatures in multi-rack solar hot box may be due to appropriate insulation thickness and heat tightness of the cover plate. The calculated value of figure of merit (F1) in solar hot box is 0.119. The trend of increase in water temperature in hot box is given in Table 4. The time duration for raising water temperature from 60 °C to 90 °C in the hot box is 120 minutes. Cooking trials have also been conducted—0.5 kg of rice in 1 litre of water and 0.250 kg of split green gram (washed) was cooked in one and a half hours in winter and about one hour in summer.

Table 3 Thermal performance in MCS for cooker with reflector for figure of merit F_1 in winter

Time (hrs)	Ambient temperature (°C)	Temperature inside the cookstove (°C)	Insolation (W/m²)
10:00	26.25	42.50	518.25
10:30	26.25	63.50	601.00
11:00	26.75	96.00	637.25
11:30	27.50	114.00	668.75
12:00	28.25	115.50	696.25
12:30	29.00	117.00	721.50
13:00	29.75	119.00	741.75
13:30	30.25	113.50	727.50
14:00	30.50	107.75	691.25
14:30	30.75	103.50	662.75
15:00	29.75	98.50	613.00
15:30	29.50	93.25	538.50
16:00	29.00	79.00	470.25
16:30	28.25	74.25	361.25
17:00	27.25	50.50	177.75

Value of F1 = 0.119

Table 4 Water heating test with reflector for fig of merit F_2 in winter

Time (hrs)	Ambient temperature (°C)	Water temperature inside the cookstove (°C)	Insolation (W/m²)
10:00	24.5	45	508
10:30	24.5	50.5	568
11:00	25.5	61	621.5
11:30	26.5	77	661.5
12:00	27.5	82.5	673
12:30	28.5	87	735
13:00	29	90.5	745.5
13:30	29.5	92.25	712.5
14:00	29.5	92.5	654.5
14:30	29.6	93.25	595.5
15:00	28.7	91.5	580

Value of F_2 = 0.32

Table 5 Energy saving and payback period of MCS

Type of fuel	Calorific valve (MJ/kg)	Efficiency (%)	cost (Rs)	Payback period (Years)
Firewood	19.89	20%	3.0/kg	1.86
Coal	27.21	20%	5/kg	1.52
Kerosene	45.55	40%	10/kg	2.56
Electricity	3.60 per kWh	80%	3/kg	1.3

The performance of hot box was observed throughout the year for stagnation temperature and water temperature. The maximum temperatures achieved are given in Table 4. The maximum stagnation temperature of 119°C and water temperature of 93.25°C were obtained in month of March.

Energy conservation and pay back period

By analysing the duration of bright sunshine hours, it has been estimated that cook stove is capable of drying and cooking for about 280 days in a year at Udaipur.

The energy required for cooking and drying is about 2.3 MJ of fuel equivalent per meal and drying. Multipurpose cook stove is capable of drying and cooking for about six persons, and it will save 50% of fuel per time. Therefore, it saves 1.15 MJ of energy per meal. Accordingly, energy saving per year was calculated and its pay back period was estimated without considering interest, maintenance, and so on.

Conclusion

The performance of multipurpose cook stove was comparable with a commercial fuel used for cooking and drying operations. The relatively short pay back period (1.3 to 2.6 years) shows that it is economical.

Acknowledgement

Authors are highly thankful to Ministry of Non-conventional Energy Sources for providing the financial assistance to carry out the research work. They are also thankful to the Department of Renewable Energy Sources, College of Technology and Engineering, Udaipur for providing all sorts of required facilities for the study.

DEVELOPMENT OF RENEWABLE ENERGY TECHNOLOGIES IN INDIA
THE ROLE OF BHEL

S R AWASTHI
General Manager (Project Management), BHEL, New Delhi

Global warming is emerging as one of the biggest challenges of this century. One of the main reasons for this is the emission of GHGs (greenhouse gases). The main source of GHGs is thermal power plants based on fast-depleting fossil fuels. Hence, there is a pressing need to go for renewable energy sources since they get replenished fast—solar, wind, hydro, biomass, and so on.

BHEL initiatives

BHEL (Bharat Heavy Electricals Ltd) realized the importance of renewable energy sources as early as in the 1980s and took initiatives in the in-house development, manufacture, and supply of a range of renewable energy products and systems. BHEL developed a range of renewable energy products and systems like:

- Solar water heaters
- Solar cells, modules, and panels
- Solar lantern
- Wind electric generators
- FBC boiler for agricultural biomass
- Battery-powered road vehicles
- Fuel cells, and so on

BHEL is one of the few organizations that have helped in making the country free from the compulsions of importing power equipment. Practically, every third house out of four in India is supplied power generated from BHEL sets. Today, the company not only plays a key role in meeting indigenous need of conventional power plant equipment but also holds impressive record of their export.

BHEL has ventured in difficult and inaccessible terrains to establish and demonstrate renewable energy technology in power-starved areas of the country. Looking beyond business interests, BHEL has focused on remote areas in Lakshadweep, Andaman and Nicobar, Sunderban Islands, the North East, and defense locations, as a part of its CSR (corporate social responsibility) initiatives.

Table 1 Indian RE scenario and BHEL's contribution

Source/System	*Estimated potential*	*All India achievement as on 31 March 2009**	*BHEL's contribution*
SPV Power (grid) >25 kWp	—	2.12 MWp	1.5 MWp
Small Hydro (up to 25 MW)	15 000 MW	2430 MW	550 MW
Wind Power	45 195 MW	10 242 MW	66 MW
Water Heating Systems	140 million m^2 collector area	2.9 million m^2 collector area	53 000, 0.1 million m^2 collector area
Solar lanterns	—	730 000	115 000
SPV Pumps	—	7148	450
SPV Street Lighting System	—	70 474	3600
SPV Home Lighting System	—	450 000	1216
PV System for Rural Radio Phone for DoT		—	30 220 sets

BHEL has also contributed 16 MWp in standalone SPV systems and 1.5 MWp in SPV power plants/packs.

Indian scenario

The Indian scenario in renewable energy and BHEL's contribution is given in Table 1.

Solar energy

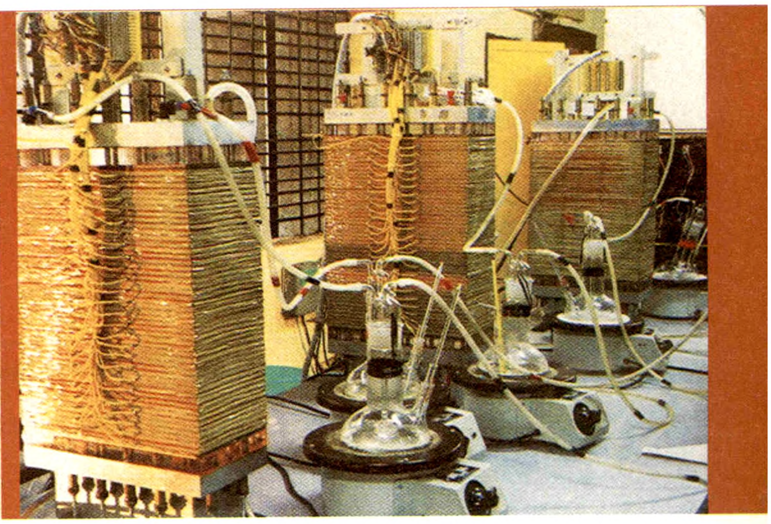
The sun provides enough energy in one minute to cater to the global energy needs for one year. India receives 5000 trillion kWh of solar energy per year.

Solar photovoltaic

In line with its CSR initiatives, BHEL paid special attention to the development of remote and inaccessible areas in the Sundarbans delta, Lakshadweep, and Andaman and Nicobar islands. The solar power plants commissioned by BHEL have heralded a new era in the lives of the islanders. BHEL commenced the manufacture of SPV (solar photovoltaic) cells and modules at its Bangalore plant in 1983. Subsequently, it set up standalone as well as grid-interactive SPV plants in remote areas. The company offered solar power plants ranging from few kilowatt-peaks to megawatt sizes. The company has modern manufacturing facility for semiconductor processes and fabrication lines for solar cells and PV modules and systems. This facility has been augmented to 8 MWp per year. So far, BHEL has supplied more than 21 MWp of solar equipment/systems.

BHEL's SPVs consist of 125 mm and 156 mm crystalline silicon cells and 10–170 Wp-capacity modules/panels. These products are designed and manufactured in a state-of-the-art facility and are certified by the Solar Energy Centre (MNRE, Government of India) and Electronic Technology Development Centre in India. These have also been design-qualified and type-test-certified by Joint Research Centre, Ispra in Italy, for IEC-61215 standards, which are recognized by international clients. Along with upgraded line, BHEL is manufacturing and supplying 225 and 270 Wp PV modules to cater to large rating solar power plant application.

In a recent initiative, BHEL and BEL (Bharat Electronics Ltd) signed a MoU to explore a 250-MW joint manufacturing facility for SPV cells, modules, and silicon wafers. The two companies will look for suitable vendors or partners for technology and supply of raw materials such as polysilicon. The joint venture, worth Rs 3500 crore, will cater to the



domestic as well as the growing export market for solar products.

The BHEL supply range covers the following.

- Rural SPV lighting (street and home lighting)
- Solar water pumping
- SPV railway distant signalling
- SPV system for microwave repeater stations and rural radio phones
- SPV systems for offshore platforms
- SPV systems for seismological equipment
- SPV systems for battery charging in rural telephone exchanges
- SPV systems for navigational aids
- Solar power plants (stand alone, grid interactive)
- Hybrid (PV Mains or PV Diesel) power plants
- Rooftop and building integrated PV

The SPV-based power plants supplied by BHEL are listed in Table 2.

Table 2 The SPV-based power plants supplied by BHEL

A) Solar power plants with rating > 15 kWp

Order placed by	*Description and quantity of ordered equipment*
Electricity department, Kavaratti, Union Territory of Lakshadweep	(i) 100-kWp SPV grid-interactive power plant at Kiltan Island (ii) 50-kWp SPV standalone power system at Bitra Island
Electricity department, Lakshadweep	Grid interactive power plant at (i) 150 kWp at Kadmat Island (ii) 100 kWp at Minicoy Island (iii) 100 kWp at Agatti Island (iv) 100 kWp at Kavaratti Island (v) 100 kWp at Androt Island (vi) 100 kWp at Kalpeni (vii) 100 kWp at Amini (viii) 100 kWp at Chetlet (ix) 50 kWp hybrid system (50 kWp SPV + 2 x 60 kW DG) at Bangaram
Electricity department, Andaman and Nicobar Island	(i) 50 kWp SPV grid interactive (with standalone facility) power plant at Neil Island (ii) 50 kWp SPV grid interactive (with standalone facility) power plant at Havelock Island
WBREDA, Kolkata	SPV Stand Alone Power Plants at : (i) 55 kWp at Mousuni Island (ii) 110 kWp at Mousuni Island—St.-II (iii) 110 kWp at Rakhalpur (iv) 55 kWp at Tushkali (v) 110 kWp at Kaylapara (vi) 55 kWp at Daudpur (vii) 55 kWp at Pathankali
APSEB, Hyderabad (now APGENCO-APTRANSCO)	100 kWp SPV grid interactive power plant installed at APTRANSCO HQ
ANERT, Thiruvananthapuram	25 kWp SPV grid interactive power plant installed at KSEB HQ
ESD, Bangalore	30 kWp SPV grid interactive power plant
HRDI, Noida	65 kWp SPV grid standalone power plant
Sirifort, New Delhi	25 kWp SPV grid standalone power plant

Table 2 The SPV-based power plants supplied by BHEL *(coninued...)*

B) SPV power plants with rating < 15 kWp (major orders)

Order placed by	*Description and quantity of ordered equipment*
Jharkhand State Tribal Cooperative Development Corporation Ltd	174 SPV standalone power systems aggregating to 614 kWp
HPCL, Mumbai	50 x 5.94 kWp SPV standalone system for fuel outlets
Chhattisgarh Renewable Energy Development Agency	26 SPV standalone power systems aggregating to 130 kWp
Karnataka police	300 grid-connected solar power packs for police stations aggregating to 67.5 kWp
Chhattisgarh State Electricity Board	9 SPV standalone power systems aggregating to 36 kWp
NTPC, Rihand	11.9 kWp standalone SPV plant at Jarah Chetwa Village at Sonbhadra District, Uttar Pradesh

Lighting system

The Rudrapur plant started manufacture of solar lanterns since 1992/93 and supplied over a lakh lanterns. BHEL supplied a large number of PV street lighting systems, home lighting systems, and school lighting systems to Tamil Nadu Electricity Board, Karnataka Electricity Board, various Islands, Tamil Nadu Energy Development Agency, Maharashtra Energy Development Agency, Pondicherry, Itanagar, and so on.

Water heating systems

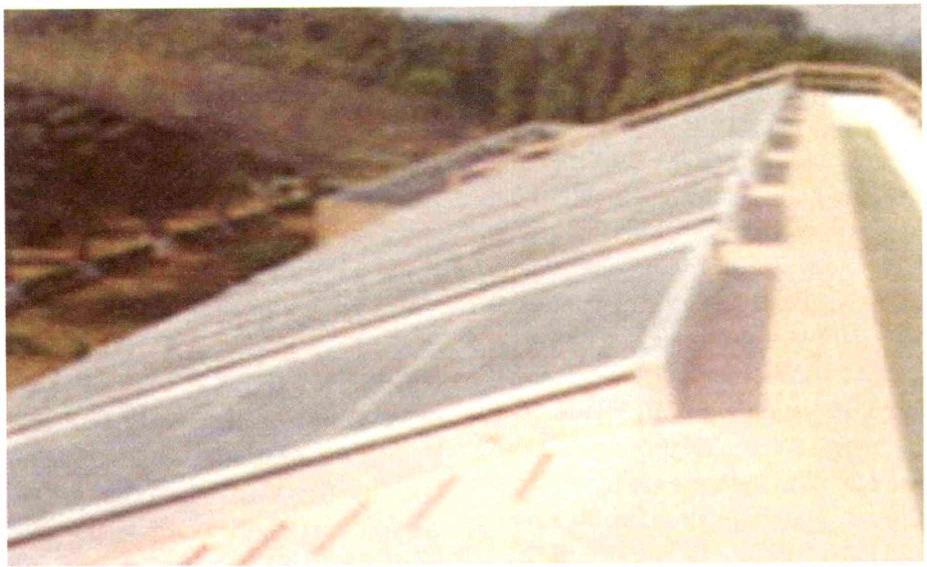
BHEL developed flat collector-type SWHS (solar water heating system) in 1985/86. In the course of development, required changes were made in the processes and materials. A dedicated facility was established at Rudrapur, Uttarakhand, to manufacture SWHS, solar lanterns, and other such products. At present there are more than 100 manufactures of SWHS with flat plate collectors in the country.

Battery-powered road vehicles

BHEL developed battery-powered vehicles through in-house R&D (research and development). BHEL has supplied about 450 BPRVs (battery-powered road vehicles) generally to public sector undertakings and few in the private sector. BHEL also developed special purpose tailor-made VVIP coaches for various zoos and so on. Further, as a part of improvement, on-board charging facility of the batteries was added. BHEL supplied BPRVs to various customers such as Delhi Development Authority, Agra Development Authority, IIT Chennai, Pathnitop in Jammu and Kashmir, and the Parliament House.

Small hydro

BHEL started design and manufacture of hydroelectric equipment at Bhopal and Haridwar in 1966. It had the responsibility of assimilating the collaborator's technology of hydroelectric equipment. Looking at the total hydropower potential in India, BHEL's contribution as on 31 March 2009 was 365 sets totalling 16 996 MW. BHEL has not limited itself to higher/ medium rating machines but has also addressed the mini/micro/small hydro needs of the utilities for special areas as



per their requirement. In small hydro, BHEL entered into a new arena and paved the way for others.

- Smallest rated bulb turbines of 6 x 1.692 MW for Sone Link Canal Project in Bihar
- Smallest rated Pelton turbine of 3 x 1.5 MW for Yazali Project, Arunachal Pradesh
- Highest speed (1500 RPM) Francis turbines for 2 x 1.5 MW for Gumma project in Himachal Pradesh
- A 100-kW tubular turbine for Kakroi to Alternate Hydro Energy Centre, Roorkee, for educational purpose
- Propeller turbines for 2 x 1.4 MW Dhupdal Project in Karnataka

Wind power

For over a decade, wind energy has been the fastest growing renewable energy source in India. BHEL took the extraordinary initiative in the field of wind electric generator when its technology was in the primitive stage in the country. The manufacturing of 200/250 kW wind turbines was taken up at BHEL's Boiler Auxiliary Plant, Ranipet, in collaboration with M/s Nordex A/s, Denmark. BHEL has also supplied to wind farms in the states of Tamil Nadu, Gujarat, Andhra Pradesh, Maharashtra, and Rajasthan.

Dual-speed generators

Wind power varies along the length and breadth of the country with the location, altitude, seasons, day temperature, and so on. In order to utilize wind energy efficiently, generators should be designed to operate at more than one discrete speed. To harness wind power at high as well as low wind speeds, BHEL has developed both the options as per customer specifications. The company has successfully designed, manufactured, and tested a 200 kW/50 kW, 6/8 pole dual speed wind electric induction generator.

Developmental activities

Amorphous Silicon: Gurgaon

R&D in SPVs first started at BHEL's Bangalore plant. Subsequently, a world class R&D facility was developed at Gurgaon to carry out research in the field of mono, multi, and thin-film silicon photocells. BHEL has developed 6" x 6" size modules, one of the biggest in the world. It also has the facility to develop suitable texturizing technology.

FBC boiler

More than 70% of India's population depends on agriculture, which results in huge biomass waste. The economically viable conversion of biomass into energy has been a challenge. BHEL accepted this challenge and developed a 10 MW rice straw-based FBC (fluidized bed combustion) boiler for the first time in the country. This project was jointly funded by DNES (Department of New Energy Systems), Punjab State Electricity Board, along with BHEL.

Fuel cell

In 1988, BHEL became the first company in India to take up fuel cell-related projects in the R&D division in Hyderabad. India's largest ever 50 kW PAFC power pack was tested at BHEL R&D during December 2000. BHEL acquired basic PEMFC technology from the IISc, Bangalore, in 2002 and developed 3 kW PEM fuel cell. BHEL installed a fuel cell plant for demonstration at BPCL's petrol pump near Hyderabad. Apart from low temperature PAFC and PEMFC, BHEL is taking initiative to develop SOFC (Solid Oxide Fuel Cells), which work at high temperature at its Ceramic Technological Institute, Bangalore.

Hybrid systems

BHEL has developed a master controller, which will ensure proper operation of the standalone wind-SPV-diesel hybrid system and allow maximum utilization of wind and solar powers, while minimizing the usage of diesel. Keeping

focus on areas that do not have access to the grid, a 100-kW hybrid system integrating wind, SPV, and diesel has been commissioned at Kavadakallu in Anantpur district in Andhra Pradesh. This technology, developed for the first time in the country by BHEL's Corporate Research and Development Division, is undergoing field trials for low and high wind applications with a provision of automatic changeover.

Building integrated SPV laminates

A process for glass-to-glass and glass-to-tedlar lamination has been developed at BHEL's SPV development centre ASSCP for making semi-transparent and opaque laminates for integrating with windows, canopies, and roofs of buildings. This will allow natural light to permeate, minimizing dependence on electric lights, in conformity with 'green building' concepts. These have been put on a room in the BHEL's ASSCP.

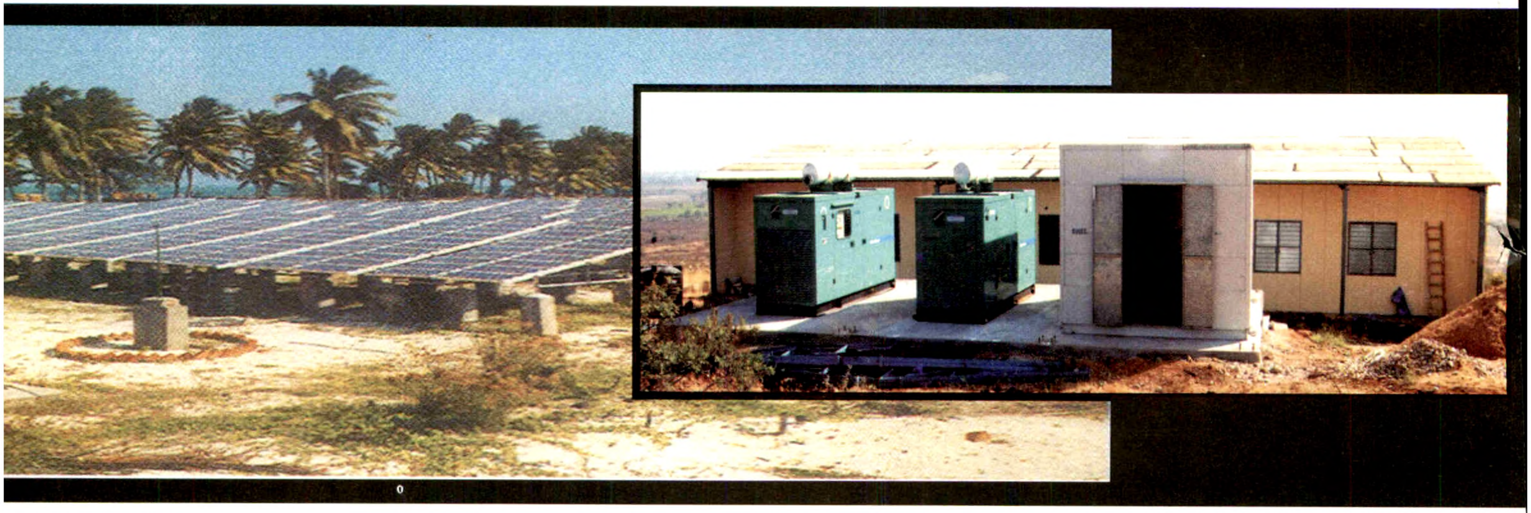
Conclusion

BHEL, apart from taking initiatives in the field of renewable energy, has been developing new technology and products to demonstrate and build up the confidence of the entrepreneur to enter these areas like solar lantern, solar heaters, WEG, and battery-powered road vehicles.

Key contributions

The major contributions of BHEL to renewable energy have been:

- **HPCL**: BHEL supplied SPV systems to M/s HPCL to illuminate and run the company-owned petrol dispensing stations smoothly, irrespective of grid power outage. The design takes care of four dispensing stations to work for at least four hours, even when the grid power is not available.
- **Lighting**: BHEL was the first to commission India's largest 105 kW standalone SPV power plant at Mousini Island in South 24-Parganas district in West Bengal on 5 April 2003. It was aimed to fulfill electricity and drinking water need of 700 homes.
- **SPV Water Pumping System**: BHEL has supplied fixed structure type systems to the Gujarat Energy Development Agency and Government of Tripura, and manual tracking type systems to Orissa Renewable Energy Development Agency, Tamil Nadu Energy Development Agency, Non-conventional Energy Development Corporation of Andhra Pradesh, DRL (Assam), Madhya Pradesh Urja Vikas Nigam Ltd, and Agency for Non-Conventional Energy and Rural Technology.
- **Transportation**: With inherent technological strength, BHEL took development of BPRV buses as a pilot project at BHEL, Bhopal. After several engineering/manufacturing trials, first bus was rolled out in early 80s. Improvements continued in load capacity, charging intervals, and a modern BPRV took shape.
- **Tsunami crisis – emergency supply of solar lanterns**: During Tsunami crisis, BHEL sent 6000 solar lanterns through air to Andaman against government order to serve lighting needs of people when the established power systems were wrecked.
- **Smart Card**: A novel method of selling electricity has also been adopted at Mousuni Island by employing prepaid energy meters on trial basis. Energy is being sold through smart cards to selected



customers who are uniquely identified with the energy meter installed in their premises.

- **Small hydro**: Installed in remote areas like Stakana and Karnah in Jammu and Kashmir, Tripura, and so on. In order to economize the cost, a load controller was developed for the first time to replace governor, which has been subsequently adopted by other manufactures.
- **Meeting challenges in space**: BHEL has tied up with ISRO (Indian Space Research Organization) to fabricate space-quality solar panels and batteries. This is an extension of its terrestrial solar cell project, and involves assembly and testing of high-efficiency, high-reliability solar panels and batteries for use in outer space.

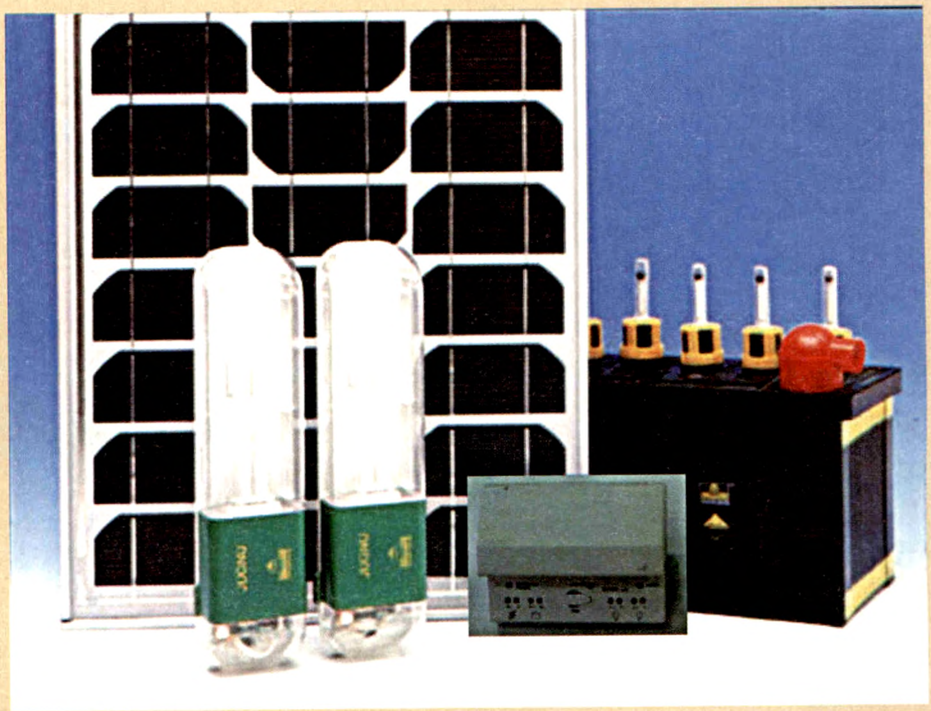
For efficient utilization of renewable energy and to minimize dependence on conventional power, governments at both the central and state levels may take policy decisions in the following areas.

- Police check posts, primary health centres, offices of gram panchayats/BDOs, and primary schools in rural and backward areas should be based completely on solar systems.
- All rural petroleum outlets of IOCs, HP, BP, and so on should be made 100% solar/hybrid.
- Traffic signalling/marking requirements in all major cities should be made SPV-based.
- All defense establishments in remote areas should be covered under solar/solar-hybrid lighting.
- Defense locations in difficult terrains, especially in the Himalayan region, should be identified with suitable mini/micro hydel plants to meet the power needs and other associated spin-outs like fishing.
- In the sensitive tribal areas, initiatives could be taken for solar, hybrid, and mini/micro hydel plants with total involvement and management of local people to provide creative alternative besides meeting power needs.
- BPRV in small and medium capacity configuration be made mandatory for use in tourist areas and by leading hotels for pick-ups/drops for their customers, PSUs for in-house requirement, and so on.
- All hoardings in metros, to start with, should have mandatory solar-powered lighting system.

DID YOU KNOW?

- In the late 15th century Leonardo Da Vinci already conceived of an industrial use of solar power by employing concave mirrors to heat water.
- In 213 BC, the hero Archimedes used solar energy to save Sicily, then called Syracuse, from Roman warships in an ambitious and unusual plan. He used mirrors to concentrate and reflect the energy from the sun onto the Roman ships, and to set them on fire so they were no longer a threat.

Solar Village - Iqbalpur



Village Iqbalpur is located near the famous Sultanpur Bird Sanctuary. It is about 15 km from Gurgaon, and comprises of about 120 families engaged in farming and related activities, such as dairying and animal husbandry. Though located near Gurgaon, the village is not different from any other remote village as far as electricity is concerned. It faces several power cuts at crucial hours.

The Sultanpur branch of GGB (Gurgaon Gramin Bank), after getting a call from its corporate office, decided to popularize SHLS (Solar Home Lighting Systems) in its operational area. Initially, it was a stupendous task to motivate the people of nearby villages to install SHLS. So, to demonstrate the utility and effectiveness of SHLS, the branch decided to install a system in its own premises so that villagers can themselves see and realize the advantages of SHLS.

The Village Pradhan of Iqbalpur also visited the Sultanpur Branch. The Branch Manager convinced him about the utility and working of SHLS. Together, they decided to hold a meeting in the village and demonstrate the SHLS.

Subsequently, a demonstration was organized in the village with the assistance of TATA BP Solar Pvt. Ltd. Apart from the demonstration of the working of the systems, the credit scheme of the Bank for purchase of such systems was also explained in detail.

GURGAON GRAMIN BANK'S 'SAUR VIDYUT SCHEME'

Major attractions and specialties

1. GGB provides loan to its existing and new customers to purchase TATA BP Solar Lighting System on easy conditions and at cheaper interest rates.
2. Loan amount : up to 85%-95% of the total cost
3. Repayment of loan : up to 5 years
4. Service charges : up to Rs 100 only
5. Security : Supervision of solar lighting systems
6. Guarantor : a reputed person

Status position of Branches' contribution in promotion of Solar Home Lighting Systems under 'GGB Saur Vidyut' scheme

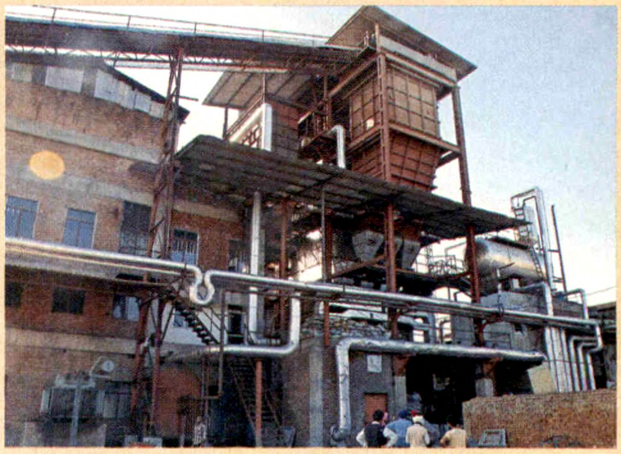
Sl. No.	Branch name	Total unit sanctioned	100% coverage of SHLS
1	Kharkhoda	251	Gopalpur village
2	Mohindergarh	159	Ballayacha village
3	Sultanpur	154	Iqbalpur village
4	Seehma	121	
5	Katesra	101	
6	Gharoda	100	
7	Badoli	80	
8	Haily Mandi	75	
9	Mandkola	70	
10	Mohna	67	
11	Kushak	60	
12	Rawli	60	
13	Dhanonda	60	

Initially, about 10 units were installed. Soon, other villagers also came forward to install SHLS with the financial assistance provided by the Sultanpur Branch of GGB. Collateral-free, hassle-free, and without-margin credit facility was extended under 'GGB Saur Vidyut Scheme' of the bank. Now every household in the village has installed a SHLS.

N T Hegde, Chairman, GGB

Vishal Paper Industries generates its own power from biomass

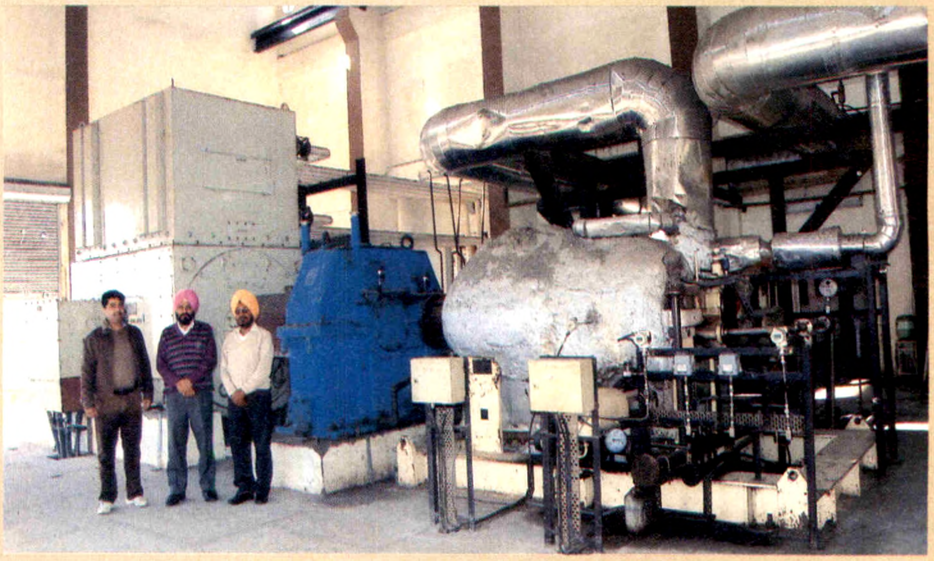
Vishal Paper Industries, situated at Village Khusropur in Patiala, Punjab, produces different types of writing and printing papers. The total production capacity is about 100 tonnes per day. The steam requirement for the company is around 12 tonnes per hour and the power requirement is about 4 MW. Due to irregular supply of power, the company has installed a 5.4 MW biomass co-generation (non-bagasse) project to meet their full requirement of power and steam, which is saving a large quantity of conventional electricity and diesel for the operation of their paper mill. The project is utilizing about 200 tonnes per day of rice husk. The pressure of steam boiler is 65 bar, and the turbine is of back pressure type, so as to extract steam also for their process requirement.



The total cost of the project is about Rs 130 million. The project was commissioned in August 2008 and is running satisfactorily. The energy generated is being utilized for captive use to meet their total heat and power requirement. With the installation of 5.4 MW co-generation project, the paper mill has become self-dependent for its captive energy requirement. The pay back period of project is about 5 years.

Giriraj Rice Mill powered by rice husk

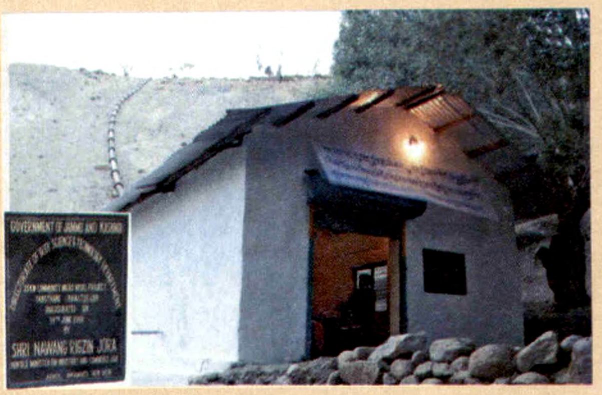
Giriraj Rice Mill is situated at Bamunpara in Burdwan District of West Bengal. The production capacity of the mill is 80 000 tonnes of paper per annum. In the process, the rice mill requires both electricity and steam. Due to irregular supply of power and frequent cuts, the mill has installed an 800 KW rice husk-based co-generation project for captive use to meet their full requirement of power and steam. This is saving a large quantity of conventional electricity and diesel for the operation of the rice mill. The project is utilizing about 70 tonnes per day of rice husk, which is available from their own rice mill. The pressure of the boiler is 32 bar, and the turbine is of back pressure type, so as to extract steam for their process requirements.



The project was commissioned in May 2008 and is running satisfactorily. The energy generated is being utilized for captive use to meet their total steam and power requirements.

With the installation of the 800 KW co-generation project, the rice mill has become self-dependent for its energy requirement. The payback period of the project is about four years. The performance of the project has encouraged a number of other rice mills in the state of West Bengal to install similar projects.

Yangthang Village of Leh runs on small hydropower



Khaltse is a very remote village of district Leh, which is 15 km from Saspol and 75 km from Leh, located on the road leading to Himsshok Village. Ladakh is situated in the Indus Valley region of Ladakh range of Karokram Mountains within a complex network of Himalayan Mountains. Minor ranges exhibit no pattern in terms of the direction of alignment. These ranges are drained by a number of rivers, which eventually end up in Indus River. Some of the peaks surrounding the village rise beyond 16 000 feet and are permanently snow-covered.

A 25 KW Micro Hydel Project was formally commissioned on 19 June 2008 at a cost of Rs 1.621 million on Yangthang stream. The project was completed within a period of one year and remained on trial before it was formally commissioned. The project provides electricity to 35 households. The area was devoid of electricity, except few households that had solar units for lighting 2–3 CFLs (compact fluorescent lamps). A Village-level Energy Committee was constituted, which has taken up the responsibility of management, maintenance, and repair after the project was handed over to the Committee. Two grass-root engineers were trained for running the project. This hydropower has the least impact on the environment. Each beneficiary contributes Rs 50 per month, which is shared among the two grass-root engineers.

Beyond lighting, the Village Energy Committee plans to install local industry for processing agriculture crops, steel works, irrigation, and so on. Presently, they have to go to Leh for milling and other such services. The village also has a small wool processing unit at home level, which could be augmented with power spinning machine. It will enable them to process a larger quantity of wool, and spinning a pashmina can also be done at home.

PARTICIPATE IN AKSHAY URJA CHILDREN'S PAINTING COMPETITION

Topic:
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group 2 – 10 to 15 years

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Shaping the future with the sun

Central Electronics Ltd

S K SANGAL
Executive Director, CEL

Introduction

CEL (Central Electronics Ltd) is a Public Sector Company under the Ministry of Science and Technology, Government of India. CEL is the nation's pioneer in the field of SPV (solar photovoltaics), and has the most modern plant to manufacture solar cells and modules at Sahibabad (Uttar Pradesh) located on the outskirts of Delhi. CEL's SPV technology is state-of-the-art and its products test qualify to international standards 'IEC 61215 (Edition-II)', certified by TUV Rheinland, Germany. CEL has developed many innovative solar products suitable for rural as well as industrial applications. CEL is actively engaged in the implementation of Rural Village Electrification programme through solar energy for more than two decades now.

CEL's mission is to achieve excellence in technology and manufacturing of solar cells and modules and be a market leader in solar energy.

Phases of SPV technology development in the company

CEL's activities in the area of SPV can be broadly broken up into the following macro-milestones (Table 1).

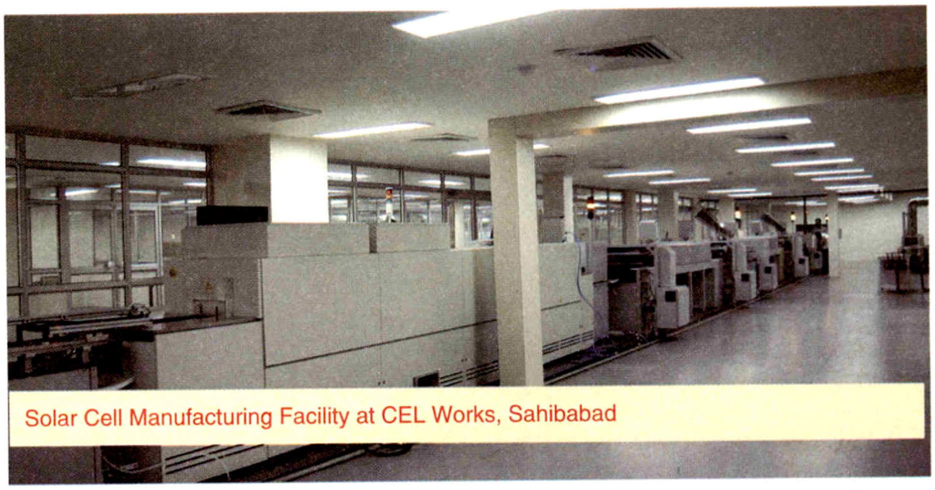
In view of the so-called 'oil crisis' in 1973, CEL was given a mandate to

Table 1 CEL's activities in the area of SPV

Year	*Area*
1976–80	R&D phase
1981–86	Pilot plant operation and demonstration programme
1986–91	Volume production and semi-commercial operation
1991 onwards	Commercial operation
2005	Capacity expansion and modernization of manufacturing plant

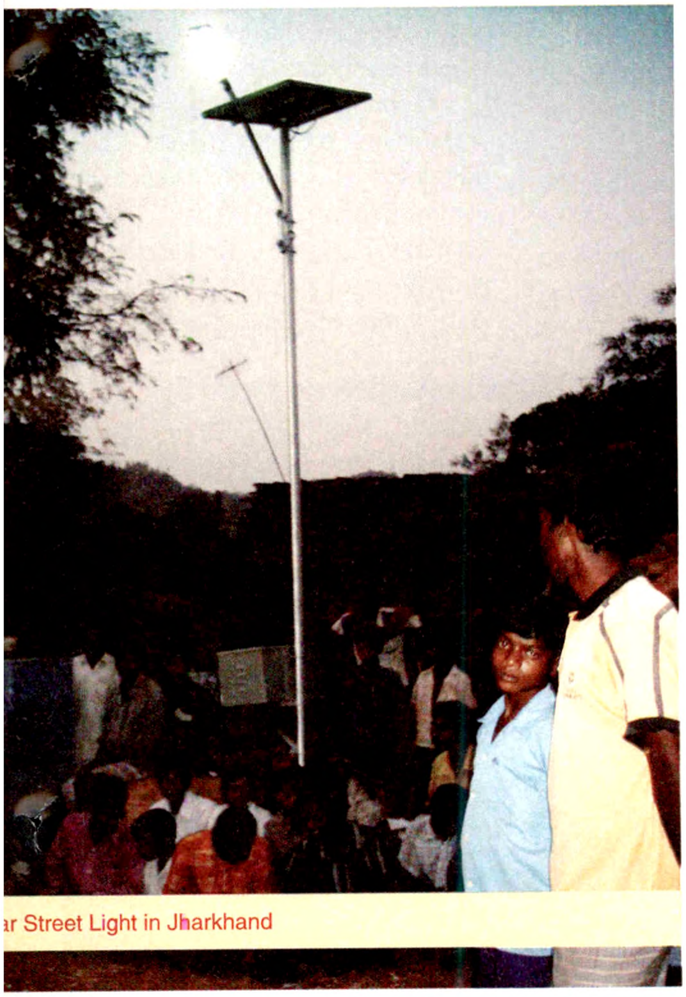
indigenously develop the technology to harness solar energy in 1976 (as India is blessed with abundant sunshine) and within a year, CEL successfully developed the first solar cell.

CEL carried out extensive in-house R&D efforts to develop the process technology to manufacture solar cells and modules. The technology is being continuously upgraded to improve on efficiency and yield. Starting from a meagre 5% efficiency on 25 mm diameter solar cells in 1977, it is now manufacturing solar cells of 156 mm x 156 mm size with more than 16% efficiency. This has been achieved through the installation of modern machines, adopting latest production techniques including anti-reflection coating and optimization of process parameters. Today, CEL has the capability to manufacture up to 225 Wp modules including BIPV (building integrated photovoltaic) modules.



Solar Cell Manufacturing Facility at CEL Works, Sahibabad

Milestones in the development of solar cells and modules in CEL are given in Table 2.



ar Street Light in Jharkhand

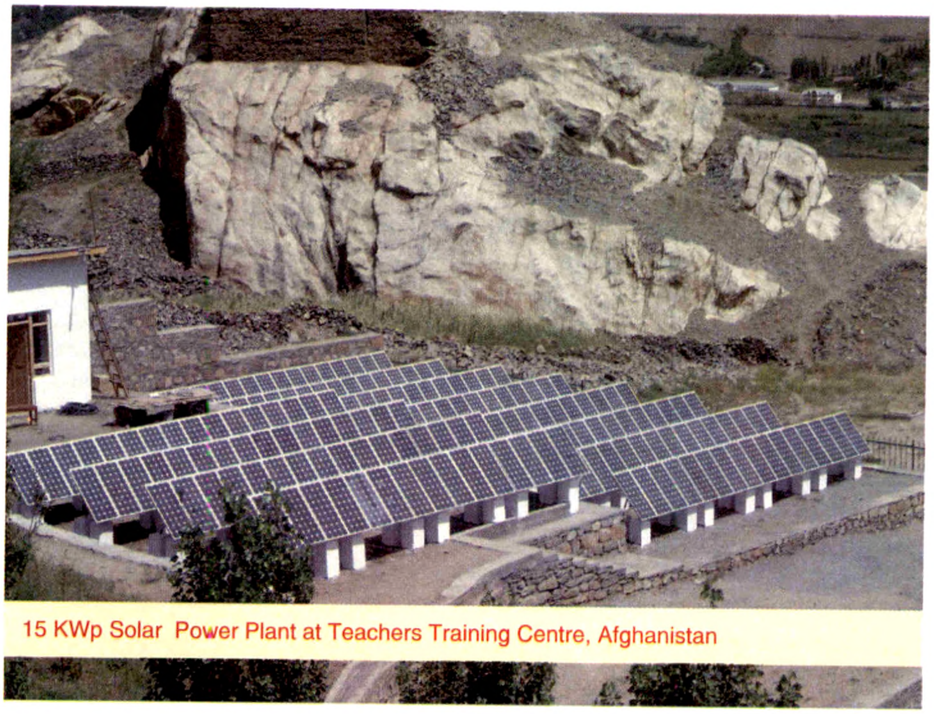
Development of SPV applications: CEL's contribution

The activities at CEL include the development of SPV applications particularly suitable to Indian conditions. CEL has developed for the first time in India, various models of solar home lighting systems; solar street lighting systems; portable solar lanterns; solar water pumps; and solar-powered systems for community centres, schools, rural health centers, and so on, to meet the rural energy needs.

CEL also developed solar-powered systems for stand alone very low power TV transmitters, communication towers,

Table 2 Milestones in solar cell/module process development

Development of first indigenous solar cell	1977
Development of first indigenous solar PV module	1978
Pilot plant production of solar cells and modules	1981
Incorporation of screen printing technology in solar cell processing	1983
Incorporation of lamination technology for PV module assembly	1986
Start of commercial scale production	1991
Increase in cell efficiency using LGBC (Laser Grooved Buried Contact) technology	1994
Incorporation of diffusion by screen printing for solar cell processing for uniform doping	1997
Test certification of PV modules as per IEC61215 by JRC, ISPRA, Italy	1998
Process optimization for achieving more than 15% solar cell efficiency	2000
Capacity expansion of manufacturing to 15 MWp	2005
Achieving more than 16% solar cell efficiency	2006
TUV Certification for PV modules as per IEC 61215 (Ed.-II)	2008
Processing of 156 mm × 156 mm crystalline silicon wafers	2009



15 KWp Solar Power Plant at Teachers Training Centre, Afghanistan

offshore oil platforms, and railway signalling and safety equipment. To meet the requirement of the Indian Army, 'Foldable Solar Battery Chargers' were designed and developed conforming to their stringent quality standards.

Major projects in India

During 2001/02, CEL electrified 90 tribal villages in Dantewara District of Bastar Region (Chhattisgarh), spread over a very large area in deep forests. The Ministry of Tribal Affairs and the Ministry of New and Renewable Energy, Government of India, funded the project jointly. With the success of this project, programme of Remote Village Electrification was initiated.

Based on the above experience, a large number of electrification projects have been taken up by CEL in Jammu and Kashmir, Punjab, Haryana, Uttarakhand, Uttar Pradesh, Jharkhand, Kerala, Assam, Manipur, and other north-eastern states.

Under the National Drinking Water Mission, CEL developed and installed Deepwell solar pumps to provide drinking water in a large number of problem villages in the country. CEL also developed 1 HP and 2 HP solar powered surface centrifugal pumps suitable for irrigation for small and marginal farmers and installed in a large number of villages throughout the country. The first 200 kWp standalone rooftop solar power plant has also been installed and commissioned for BKES (Brahma Kumaris Educational Society).

Major projects abroad

CEL is proud to have showcased Indian PV Technology in many Asian, African, and Latin American countries. Over the last 15 years, it has shared its experience with many countries and hundreds of technicians in Asia and Africa have benefited from training programmes organized by CEL.

Electrification of villages in Mali

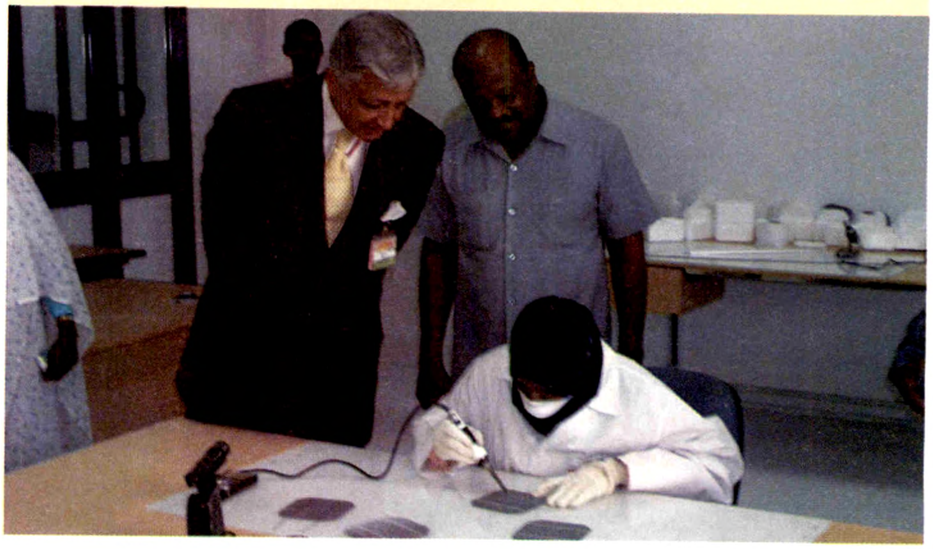
In 1997, CEL electrified one village in Mali. Since then, the Government of Mali has initiated a big programme for electrification of villages with CEL's collaboration. Recently, CEL has extended the agreement with them for next five years programme.

Electrification of remote villages in Afghanistan

In 2006, CEL executed a prestigious project for electrification of 101 remote villages in Afghanistan under extremely hostile conditions.

Similar projects have been undertaken for technology demonstration in Nepal, Bhutan, Myanmar, Mongolia, Namibia, Senegal, Burkina Faso, Cuba, Colombia, and many other countries. The people in

Solar Module Manufacturing Facility established by CEL in Sudan



these countries have become familiar with the use of solar energy and its benefits. They are themselves installing the solar equipment supplied by CEL and these systems have resulted in the upliftment of children and women folk.

Technology export

Apart from transferring the PV manufacturing technology to associates in India, CEL has also transferred its technology for manufacturing PV modules to Syria and Sudan. This is probably the first of its kind 'technology export' from India under the 'South–South Co-operation' programme. Similar agreements are under progress for Mozambique and other African countries.

The milestones in various applications developed/achievements are given in Table 3.

Sun: our inspiration

CEL is committed to harness the benign source of solar energy and to reach the under privileged population bereft of energy in India. CEL's endeavour to improve the quality of life of people in remote unelectrified villages goes on.

Table 3 Milestones/achievements in solar applications

First solar PV operated radio set in Jammu and Kashmir	1978
First solar lighting system installed at SOS children's village, Leh (Ladakh)	1980
First solar powered water pumping system installed at Awania, Gujrat.	1981
Solar foldable modules for defence applications	1984
Solar water pumping systems under the National Drinking Water Mission	1989
10 kWp solar power plant for Dr M S Swaminathan Foundation	1993
Village electrification project in Cuba	1995
Development of 25 kWp SPV–diesel hybrid power plant	1996
Solar electrification of 90 tribal villages in Bastar Region of Chhattisgarh state	2001
Installation of 30 kWp solar power plant at Taj Mahal, Agra	2002
Design and installation of BIPV modules (25 kWp) for Punjab Energy Development Agency in Chandigarh	2004
Transfer of technology to manufacture SPV modules to Ministry of Science and Technology, Government of Sudan	2005
Installation of 200 kWp rooftop solar power plant for BKES	2006
Solar electrification of 101 villages in Afghanistan	2007
Installation of 50 kWp solar power plant at Rashtrapati Bhawan	2009

Inviting advertisements for Akshay Urja

Akshay Urja is widely circulated to various stakeholders of renewable energy. *Akshay Urja* invites advertisements (in colour) from interested organizations, manufacturers, institutions, etc. The advertisement tariffs are as follows.

Advertisement area	Tariff (rupees)*
Inside Front Cover	40 000
Inside Back Cover	40 000
Full Page	25 000

* Avail 25% discount on booking for six issues and 20% discount on booking for three issues

The interested organizations may write to:
Editor, *Akshay Urja*
Ministry of New and Renewable Energy
Block - 14, CGO Complex, Lodhi Road, New Delhi – 110 003
Tel. +91 11 2436 3035 or 2436 0707 • Fax +91 11 2436 3035 or 2436 1298
E-mail aktripathi@nic.in

Interview with

Mr Debashish Majumdar

Chairman and Managing Director, IREDA

Debashish Majumdar is the Chairman and Managing Director of IREDA (Indian Renewable Energy Development Agency), a financial institution set up by the Government of India that finances projects related to renewable energy and energy efficiency. An engineer from Indian Institute of Technology, Delhi, Mr Majumdar's experience spans over 30 years in the field of renewable energy. He has been with IREDA for over eleven years. Akshay Urja team talks to him about his journey, his achievements, and the future of IREDA and the renewable energy sector.

Q.1 You assumed the office of Chairman and Managing Director of IREDA almost two years back. Could you kindly sum up the major achievements of your organization at this stage?

A: I have been the acting MD since December 2004 and have assumed charge as the Chairman and Managing Director of IREDA in June 2007. In 2004, when I took charge as acting MD, IREDA's operations were not in a very healthy state. It was plagued with high levels of NPAs (Non-performing Assets) and low sanctions. Even disbursements stood at an abysmally low level of about Rs 2900 million. From that dismal situation, IREDA has steadily gone through a healthy transformation and has achieved disbursement levels of around Rs 7700 million in 2008/09. Sanctions during the year have also grown substantially to around Rs 15 000 million. This year, we hope to do much beyond that both in terms of sanctions and disbursements, while bringing down NPAs to a negligible level. Our growth on year to year basis for the past few years is more than 25%, in spite of the current global financial crisis.

Q.2 You have just moved into a new office ambience. So, what are the newer initiatives that are on their way to progressive implementation?

A: First of all, new office ambience is not what creates new initiatives. New initiatives flow from overall objectives of growth, sustainability, and leadership. Towards this end, IREDA has consistently taken steps to maintain its leadership role as a dominant player in the renewable energy space. We have broadened our portfolio to include financing of energy efficiency and conservation projects, and medium and large hydro power projects. Innovative schemes have also been introduced for providing bridge financing for bagasse cogeneration projects, seeking loans under the Sugar Development Fund. In order to expand IREDA's reach and increase market penetration, it has also entered into Memorandums of Understanding with the Power Finance Corporation and PTC Financial Services Ltd. Special efforts have also raised the resources at competitive rates even at times when favourable conditions did not exist in the financial markets. For the first time, IREDA has also raised resources to the tune of Rs 1000 million through taxable bonds that are listed in the stock market.

Q.3 IREDA has made the maximum loan disbursements in the area of wind energy in comparison to other renewable energy areas so far. How long is this trend going to continue and for what reasons?

A: Requirement for loans would obviously depend upon the projects being set up by investors. Power generation through wind energy as a renewable energy investment is favoured amongst project promoters. As long as power producers and project developers find investments in wind to be attractive, loans in this sector would continue to be high. Wind sector would continue to find favour because of its inherent advantages in terms of well-researched resource assessment, modular units for installation, low gestation period, proven technology, low land requirement, and so on. Other renewable energy sectors do not often have these inherent advantages.

Q.4 IREDA has been rated high as per the performance indicators set up by various multilateral and bilateral funding agencies. When do we expect to break a new ground, for example any fresh line of credit for the solar energy commercialization programme?

A: IREDA has been very successful in attracting specific and targeted lines of credit from various multilateral and bilateral sources. Some of these lines of credit had soft terms, but generally, these are mixed lines of credit whose costs are some what less than commercial borrowings. We have recently signed a line of credit with KfW, Germany for 50 Million Euro. We are also in the final stages of discussions for another line of credit from them for about 20 Million Euro which is specifically aimed at removal of barriers in the biomass sector. We are also in discussion with JICA , Japan and AFD, France for various lines of credit.

Financing of solar energy projects would necessarily require funds at very soft terms because of the intrinsically high cost of solar projects and the risks associated with some of the newer technologies. We are presently discussing with Asian Development Bank for a specialized funds for financing solar energy pilot projects. Based on the success of the pilot projects, larger funds can be structured.

Q.5 IREDA has been at the forefront of advancing soft loans for a variety of activities, be it manufacturing or system installation etc. Its appraisal skills are widely acknowledged. But has there been a real problem of customers who had their loan applications appraised heading for other financial institutions thus leading to precious loss of both time and resources at IREDA?

A: Firstly, there never has been a real problem on this count. It is true that few loan applicants have obtained sanctions from IREDA but have decided to obtain loans from other lenders. This is a normal business practice and choice of lender would depend upon the terms and conditions associated with the loan.

> *“A small solar cell can generate a small amount of energy to power your calculator and the same technology can generate energy on a large scale also.”*

Q.6 The generation-based incentive for setting up solar thermal and solar PV based power plants has been a much talked about affair in the recent times. Could you please share the larger outcome of this scheme with our readers at this point of time?

A: The GBI has sown the right seeds. The most important outcome is that several states like Gujarat, Rajasthan etc. are clearly able to recognize the sun as a great resource and are able to identify the immense opportunity that solar energy can create along with the vast tracts of the barren land. These states have accordingly announced favourable policies to attract investments in the solar energy sector.

Q.7 You have been a strong votary of recommending an enhanced utilization of various RE technologies in different sectors of our economy. Which sectors in your perception are going to be the leading platforms as far as actual deployment of such technologies is concerned?

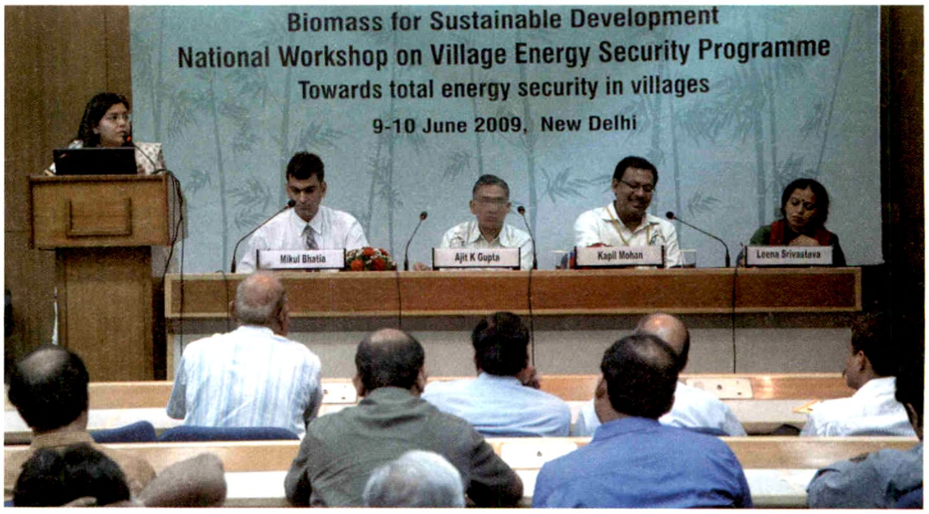
A: That's a difficult question because technologies keep changing with time. However, as evident even now wind would continue to have a leading edge over others for obvious reasons that I have mentioned earlier. In the medium term, there is likelihood of strong competition from the solar thermal power generation technologies subject to successful deployment of the first few plants. Another sector that would consolidate itself would be small hydro but these projects require long gestation period and are often technically complex from an implementation view point.

Q.8 Finally, what message would you like to give to the readers of Akshay Urja?

A: I would like to remind all readers of Akshay Urja that each one of us must sincerely participate and contribute our mite in ensuring sustainable development through the clean and green route of renewable energy. If we really want to do good for this Earth and our future generations, we must always keep in mind the old saying that “We have not inherited this Earth from our forefathers but have only borrowed it from our children”. It is a great responsibility on each one of us. We must recognize this and act accordingly.

National Workshop on Village Energy Security Programme

TERI (The Energy and Resources Institute) organized a National Workshop on the Village Energy Security Programme at India Habitat Centre, New Delhi, on 9–10 June 2009.


Biomass for Sustainable Development
National Workshop on Village Energy Security Programme
Towards total energy security in villages
9-10 June 2009, New Delhi
Mikul Bhatia
Ajit K Gupta
Kapil Mohan
Leena Srivastava

The speakers during the National Workshop on Village Energy Security Programme at India Habitat Centre, New Delhi.

> *Biomass is an important renewable energy source, as it contributes around 30% of total primary energy consumed in the country. Bulk of our present rural energy consumption comes from non-commercial energy in the form of traditional biomass used at very low efficiencies. Based on this, a concept of providing energy security through biomass in villages has been evolved by the MNRE (Ministry of New and Renewable Energy). The objective is to go beyond mere electrification per se and meet the total energy requirements of villages including cooking, lighting, motive power, and electricity generation.*

The workshop included representatives from State Nodal Agencies, existing and prospective project implementation agencies of VESP projects, Village Energy Committee members of VESP projects, non-governmental organizations, Panchayati Raj institutions, community and rural development agencies, forest departments, MNRE, Ministry of Power, and so on.

Dr Leena Srivastava, the Executive Director of TERI, talked about how the high economic growth of India is putting a huge pressure on all our energy resources. India provides tremendous amount of subsidy to the energy sector, but this subsidy is not enough to meet the total enegy requirements of the country.

Mr Ajit K Gupta, former adviser and head of VESP, mentioned that India is facing major challenges in ensuring energy access to its rural population. Though one of the major challenges have been faced in setting up of the VESP projects and their sustainable operation through community participation, the projects have motivated the community (especially the youth) to develop their skills to operate the installed power generation systems in almost all the VESP test projects.

The village Energy Committee presidents mentioned that they had been running the systems well and due to the proper training, capacity building, and time to time refresher courses of training, technical maintenance of the systems are being done.

Organizations like BERI, UNDP-GEF, ARTI (Appropriate Rural Technology Institute), SKG Sangha, Krishi Gram Vikas Kendra, DESI Power shared their experiences of running various decentralized rural energy initiatives. The participants discussed the convergence issues of various rural electrification initiatives in India and deliberated the way forward.

Dr Priti Kumar, Task Team Leader, Biomass for Sustainable Development of the World Bank gave a special address to share the Bank's experience of working in the programme. She said the idea was to develop biomass energy-based interventions focusing on sustainability to learn lessons from the technology options, consumer acceptability, financial arrangements, institutional sustainability, and so on to scale it up to a lager operational phase.

APEDA provides solar lighting systems to 5000 houses in the border villages of Arunachal Pradesh

About 5000 houses in the villages situated on the border of the northeastern state of Arunachal Pradesh have been provided with solar home lighting systems. This electrification is being done under the Prime Minister's Special Package on illumination/electrification of all border villages of the state through solar, hydro, and micro-hydel systems. A total of Rs 275.58 crore will be spent on the project in three years. Within the next one month, another 800 houses will be illuminated under the scheme, and the remaining villages would all be covered within a span of two years.

APEDA
DISTRICT ADVISORY COMMITTEE (DAC)
ON RENEWABLE ENERGY
Dated : 29th May 2009
Venue : Al Hotel Arun Subansiri, Itanagar
Sponsored by : MNRE GOI, New Delhi

Speakers during the one-day orientation-cum-training programme of DAC members of Arunachal Pradesh.

The project has been executed in association with APEDA (Arunachal Pradesh Energy Development Agency) and DHPD (Department of Hydro Power Development) of Government of Arunachal Pradesh. The MNRE (Union Ministry of New and Renewable Energy) has said that out of the 1483 villages that need to be electrified, 425 villages are covered through 46 ongoing small hydro power projects. The remaining 1058 villages were proposed to be taken up in two phases. In phase I, 546 villages were proposed to be covered through solar photovoltaic lighting and 334 villages through 137 micro hydel projects. In phase II, 178 villages would be illuminated through 16 small hydro power projects.

With a view to create large-scale awareness and publicity about the uses and benefits of renewable energy sources like solar, wind, biomass, and hydro, the MNRE has constituted 560 DACs (District Advisory Committees) for the project under the chairmanship of Deputy Commissioner and members from various state government departments and non-governmental organizations.

Glimpses of the training of DAC members

On 29 May 2009, a one-day orientation-cum-training programme of DAC members of Arunachal Pradesh on renewable energy was organized at the capital city of Itanagar by APEDA. The programme was attended by Deputy Commissioners of West Kameng, Tirap, Dibang Valley, Upper Subansiri; ADCs of East Siang and West Siang; and more than 60 members of DACs.

Speaking on the occasion, Dr N P Singh, Advisor of MNRE, mentioned that about 15 000 MW grid power from renewable energy – about 9% of the total grid power in the country – has been installed. Mr Marki Loya, Director of APEDA, gave a presentation on various renewable energy schemes that are under implementation in the state. He also requested more participation of DAC members in these schemes. During the interaction sessions, the DACs presented their views, and highlighted the benefits of renewable energy and existence of DACs.

SOLAR POWER:

Free power for the future

MANASWINI SHARMA, Class 9th, Chinmaya Public School, New Delhi

The world's energy sources are slowly declining, as our supply of fossil fuels grows scarce. Since fossil fuels are non-renewable, we will have no other source of energy to depend on unless we find another solution. Oil and gas are running short, and although coal is readily available, it is harmful to the environment. Engineers need to come up with a solution that people will actually use, while at the same time be beneficial to the earth's 'health'. In other words, they need to find the light at the end of the tunnel. Although many possibilities are readily available for engineers, such as wind power and ocean currents, they should focus on solar energy. Solar energy is an ideal solution to the current crisis because there is a plentiful supply, it's an all-purpose energy source that's safe for humans, and it's affordable.

Obviously, solar energy comes from the sun, but what does that mean for us? Unlike oil and gas, which will eventually 'die out', solar energy will always be 'in stock'. Although not as profuse in some areas as others, all places are adequately supplied with solar power. The sun gives us 10,000 times as much energy as we actually use. Instead of wasting precious resources such as oil and gas, why not use a resource that never runs out? If solar energy is virtually everywhere, why not take advantage of what it has to offer?

Not only is solar energy in ample supply, it is also useful and safe for mankind. Solar energy has the ability to power calculators, watches, and houses, and heat greenhouses, large buildings, and swimming pools. It can be converted into heat and electricity through PV (photovoltaic) devices, and can power your microwave so that you can have your lunch! Even Honda, a car company, has been involved in the making of PV devices. Although not economically feasible at present, solar energy can also power cars. When this is developed, we can make the world a healthier place to live and make many more scientific breakthroughs. Unlike gas, solar energy has little to no negative effects on the environment, such as releasing CO_2, so having solar-powered cars would be a major achievement.

Solar energy is useful in so many ways and safe for the environment, and is also less expensive than current systems in the long run. We could eventually get to a point where it will become necessary to utilize the full potential of solar power, so we should start as soon as possible.

Energy is and will become even more of a major factor in the future of engineering, because it is what we live by. Energy is needed in this world so desperately that engineers need to start thinking about renewable sources of energy. We cannot depend on fossil fuels and non-renewable energy sources forever. Solar energy provides a clean and efficient way to power our lives, and it is time that scientists took solar energy seriously as a major source of energy for the future. Until then, we need to concentrate on what we have now, and use it wisely. Remember: it's not only what we use, but also how we use it.

Send in your contribution to the following address, which will be published in the forthcoming issue of *Akshay Urja*.

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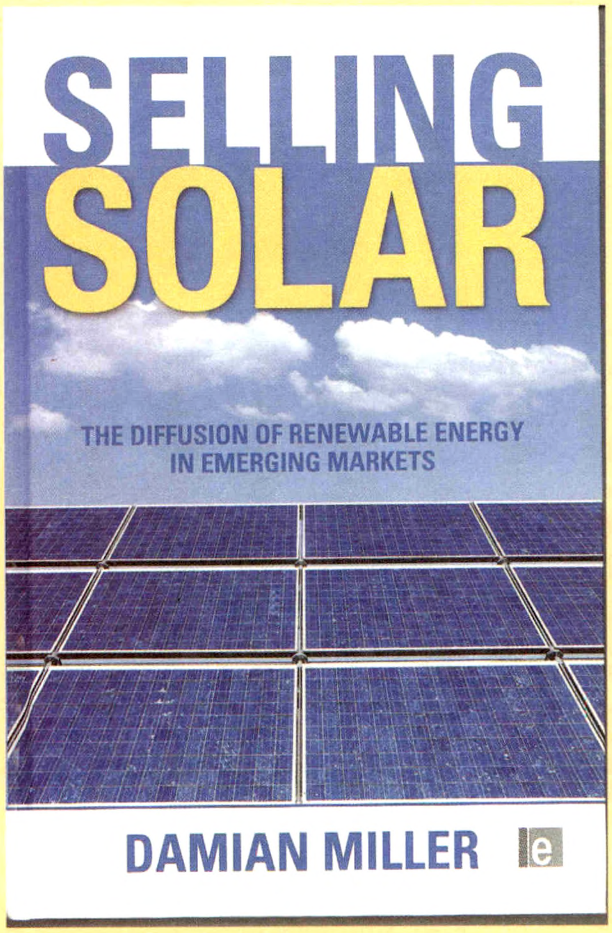
Selling Solar:

the diffusion of renewable energy in emerging markets



Selling Solar: the diffusion of renewable energy in emerging markets
Miller D. 2009
London: Earthscan • ISBN: 978-1-84407-518-8
Price: $78.00

To solve the climate crisis, the world must make a wholesale shift to renewable energy technologies. With surging growth in emerging markets, this transformation takes on even greater urgency. The challenges – and opportunities – are immense. Selling Solar considers how such a shift might happen. Focusing on the case of solar photovoltaic, it shows, how at the start of the 21st century, this technology began to diffuse rapidly in select emerging markets, after years of struggling to take off. What were the initial barriers to diffusion? How were they overcome? Who did it? And how can this success be replicated?

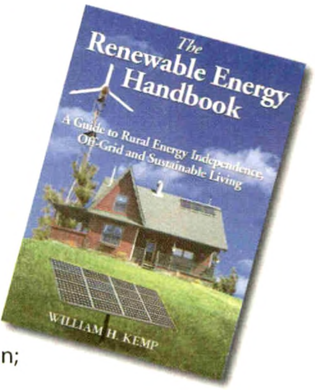
Selling Solar is a hybrid in many senses. It not only devotes many of its pages to the empirical case of solar, but also tries to bring some theoretical foundation to the case. It delves deep into the details of solar energy diffusion and tries to step back and generalize about renewable energy diffusion more broadly. It identifies the transformative power of entrepreneurs and the key role of policy-makers in providing the right incentives. It builds on the author's earlier experiences in academic research and also tries to bring a practitioner's eye to the matter. The melding of different objectives and perspectives will make this book appealing to a whole range of people.

This book belatedly tries to give the readers examples of where businesses have been trying to bring cleaner energy technology to the market, and diffuse it on a large-scale basis in emerging markets and where policy-makers stepped in to either assist this process or hamper it. Drawing on literature on innovation diffusion and entrepreneurship, the author answers these questions, showing how entrepreneurs affected profound technological change not just through the solar systems they sold, but through the example they set to both new market entrants and policy-makers. In analysing how this happened, this book offers important lessons for the diffusion of a range of renewable energy technologies in emerging markets, and for the advancement of the sector as a whole. This book is written from the perspective of someone who has both influenced and analysed the diffusion of solar energy in emerging markets. It is essential reading for anyone who believes in a renewable energy future and wants it sooner rather than later.

Reviewed by Ambika Shankar

The Renewable Energy Handbook: a guide to rural independence, off-grid, and sustainable energy

Kemp W H. 2005
Canada: Aztext Press

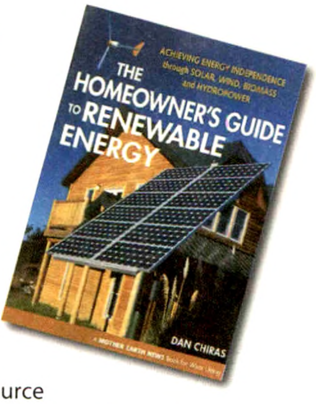

The Renewable Energy Handbook
A Guide to Rural Energy Independence, Off-Grid and Sustainable Living
WILLIAM H. KEMP

The Renewable Energy Handbook focuses on the unique requirements of off-grid living and contains chapters on energy conservation; heating and cooling; backup power; domestic water heating; wireless communications; photovoltaic, wind, and microhydro energy generation; battery selection; and inverters.

ISBN: 978-097-33233-20
Price: $22.76

The Homeowner's Guide to Renewable Energy: achieving energy independence through solar, wind, biomass, and hydropower

Chiras D D. 2006
Canada: New Society Publishers

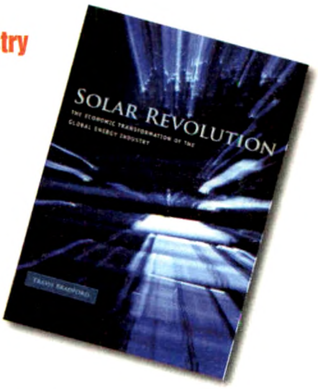

ACHIEVING ENERGY INDEPENDENCE through SOLAR, WIND, BIOMASS and HYDROPOWER
THE HOMEOWNER'S GUIDE TO RENEWABLE ENERGY
DAN CHIRAS
MOTHER EARTH NEWS

The Homeowner's Guide to Renewable Energy gives readers sufficient knowledge to hire and communicate effectively with contractors and, for those wanting do installations themselves, it recommends more detailed manuals. With a complete resource listing, this well-illustrated and accessible guide is a perfect companion for illuminating the coming dark age.

ISBN: 978-086-57153-63
Price: $21.24

Solar revolution: the economic transformation of the global energy industry

Bradford T. 2006
USA: MIT Press



In Solar Revolution, fund manager and former corporate buyout specialist Travis Bradford argues — on the basis of standard business and economic forecasting models — that over the next two decades solar energy will increasingly become the best and cheapest choice for most electricity and energy applications. The book outlines the path by which the transition to solar technology and sustainable energy practices will occur.

ISBN: 978-026-20260-48
Price: $16.47

Internet resources

Alternative fuels and advanced vehicles data center

http://www.afdc.energy
gov/afdc

The AFDC (Alternative Fuels and Advanced Vehicles Data Center) is a comprehensive clearing house of data, publications, tools, and information related to advanced transportation technologies. Sponsored by the US Department of Energy's clean cities initiative and technically administered by the National Renewable Energy Laboratory, the AFDC hosts more than 3000 documents, interactive tools that help fleets and consumers make transportation decisions, and a wealth of information to educate the public on alternative fuels and advanced vehicles. The educational tools and information featured in the AFDC are geared toward helping consumers and fleets reduce petroleum consumption.

Solar energy

http://www.solarbuzz.com

Solarbuzz is an international solar energy research and consulting company. The mission of Solarbuzz is to be the leading SPV (solar photovoltaic) energy consultancy in the world. Through the website, the user can get information on Global Solar Market and Supply Developments, access to solarbuzz research and consultancy services, or connect to Solar Energy Companies Worldwide. The website also provides world solar energy news, weekly newsletter on solar energy, and information on solar energy products.

International Association of Hydrogen Energy

International association for hydrogen energy
Clean and Abundant Energy for Sustainability

http://www.iahe.org

The International Association of Hydrogen Energy stimulates the exchange of information in the hydrogen energy field through its publications and sponsorship of international workshops, short courses, and conferences. In addition, the association endeavours to inform the general public of the important role of hydrogen energy in the planning of an inexhaustible and clean energy system. The website provides organization information, technical papers on hydrogen safety and other topics, events, news, and links related to hydrogen energy.

National events

Fourth South Asia Renewable Energy Conference 2009
29 July 2009, Hotel Le Meridien, New Delhi

The Associated Chambers of
Commerce and Industry of India
1, Community Centre, Zamrudpur
Kailash Colony
New Delhi – 110 048
Tel. +91 11 4655 0555
Fax +91 11 4653 6481/82
E-mail energy@assocham.com
Web www.assocham.org/4asia

Renewable Energy India 2009 Expo
10–12 August 2009, New Delhi

Rajneesh Khattar
Exhibitions India Group
217-B, (2nd Floor)
Okhla Industrial Estate
Phase III, New Delhi – 110 020
Tel. +91 11 4279 5000/054
Fax +91 11 4279 5098/99
E-mail rajneeshk@eigroup.in

Empower India 2009
20–22 August 2009, Mumbai, India

Urjavaran Foundation
128, Arun Chambers
Tardeo, Mumbai - 400 034
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Fax 022 2351 1825
E-mail empower@urja.org.in
Web www.urja.org.in
Event website www.empowerindia.com

World Hydrogen Technologies Convention
26–28 August 2009, IIT Delhi

Hauz Khas,
Delhi, Delhi – 110 016
Tel. 011 2658 2277
Web www.iitd.ac.in

ICORE (International Congress on Renewable Energy) 2009
6–7 October 2009, New Delhi

The Stein Auditorium
Habitat World,
India Habitat Centre
Lodhi Road
New Delhi – 110 003
Web www.icoreindia.org

Third Renewable Energy Finance Forum
20–21 November 2009, Mumbai

Maria Ferreiro
E-mail mferreiro@euromoneyplc.com

Methane to markets: partnership expo
2–5 March 2010, New Delhi

Tel. +1 (202) 343 9683
E-mail asg@methanetomarkets.org

The first Annual Renewable Energy Business Conference
19-20 January 2009

Intercontinental: The Grand,
Mumbai, 204-205, Town Centre,
2nd Floor, Andheri-Kurla Road,
Sakinaka, Andheri (E)
Mumbai - 400 059
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International

Wind Expo 2009
2–4 September 2009, Panama City, Panama

Av. Terranova 1091-2
Guadalajara México
Tel. +52 33 3817 8300
Fax +52 33 3817 8758
Web http://www.windexpo.org/2009/ing/index.html

24th European Photovoltaic Solar Energy Conference & Exhibition (EUPVSEC)
21–25 September 2009, Germany

WIP-Renewable Energies
Conference Secretariat
Tel. +49 89 720 127–35
E-mail pv.conference@wip-munich.de

ISES Solar World Congress 2009
11–14 October 2009, Johannesberg, South Africa

Tel. +27 12 807 7171
Fax +27 86 559 4753
E-mail info@swc2009.co.za
Web http://www.swc2009.co.za/

Solar Power 2009
27–29 October 2009, Anaheim, California, USA

Tel. 1 202 857 0898
Fax 1 202 682 0559
E-mail ebrown@solarelectricpower.org

Congress on Alternative Energy Applications
2–6 November 2009, Kuwait

Dr Salah Almudh'hi
Web http://www.ec2009kuwait.org/

Renewable energy at a glance in India

S.No.	Source/system	Estimated potential	Achievement as on 30 June 2009
I	**Power from renewables**		
A	**Grid-interactive renewable power**	(MW)	(MW)
1	Wind power	45 195	10386.00
2	Bio power (agro residues and plantations)	16 881	736.10
3	Bagasse cogeneration	5 000	1134.73
4	Small hydro power (up to 25 MW)	15 000	2454.67
5	Energy recovery from waste (MW)	2 700	58.91
6	Solar photovoltaic power	—	2.12
	Sub total (A)	**84 776**	**14772.53**
B	**Captive/combined heat and power/distributed renewable power**		(MW)
7	Biomass/cogeneration (non-bagasse)	—	170.78
8	Biomass gasifier	—	165.16
9	Energy recovery from waste	—	34.06
	Sub total (B)	**—**	**370.00**
	Total (A+B)	**—**	**15142.53**
II	**Remote village electrification**	—	5 453 villages/hamlets
III	**Decentralized energy systems**		
10	Family-type biogas plants	120 lakh	41.27 lakh
11	Solar photovoltaic systems	50 MW/km^2	120 MWp
	i. Solar street lighting system	—	70 474 nos
	ii. Home lighting system	—	450 000 nos
	iii. Solar lantern	—	730 000 nos
	iv. Solar power plants	—	8.01 MW$_p$
	v. Solar photovoltaic pumps		7148 nos
12	Solar thermal systems		
	i. Solar water heating systems	140 million m^2 collector area	2.90 million m^2 collector area
	ii. Solar cookers		6.57 lakh
13	Wind pumps		1347 nos
14	Aero generator/hybrid systems		0.89 MW$_{eq}$
IV	**Awareness programmes**		
16	Energy parks	—	511 nos
17	Aditya Solar Shops	—	284 nos
21	Renewable energy clubs	—	521 nos
22	District Advisory Committees	—	560 nos

MW – megawatt; kW – kilowatt; MW$_p$ – megawatt peak; m^2 – square metre; km^2 – kilometre square

Renewable Energy

Akshay Urja

Volume 3 ■ Issue 1
August 2009

अक्षय ऊर्जा से देश विकास

गांव गांव बिजली, घर घर प्रकाश

Ministry of New and Renewable Energy
Government of India
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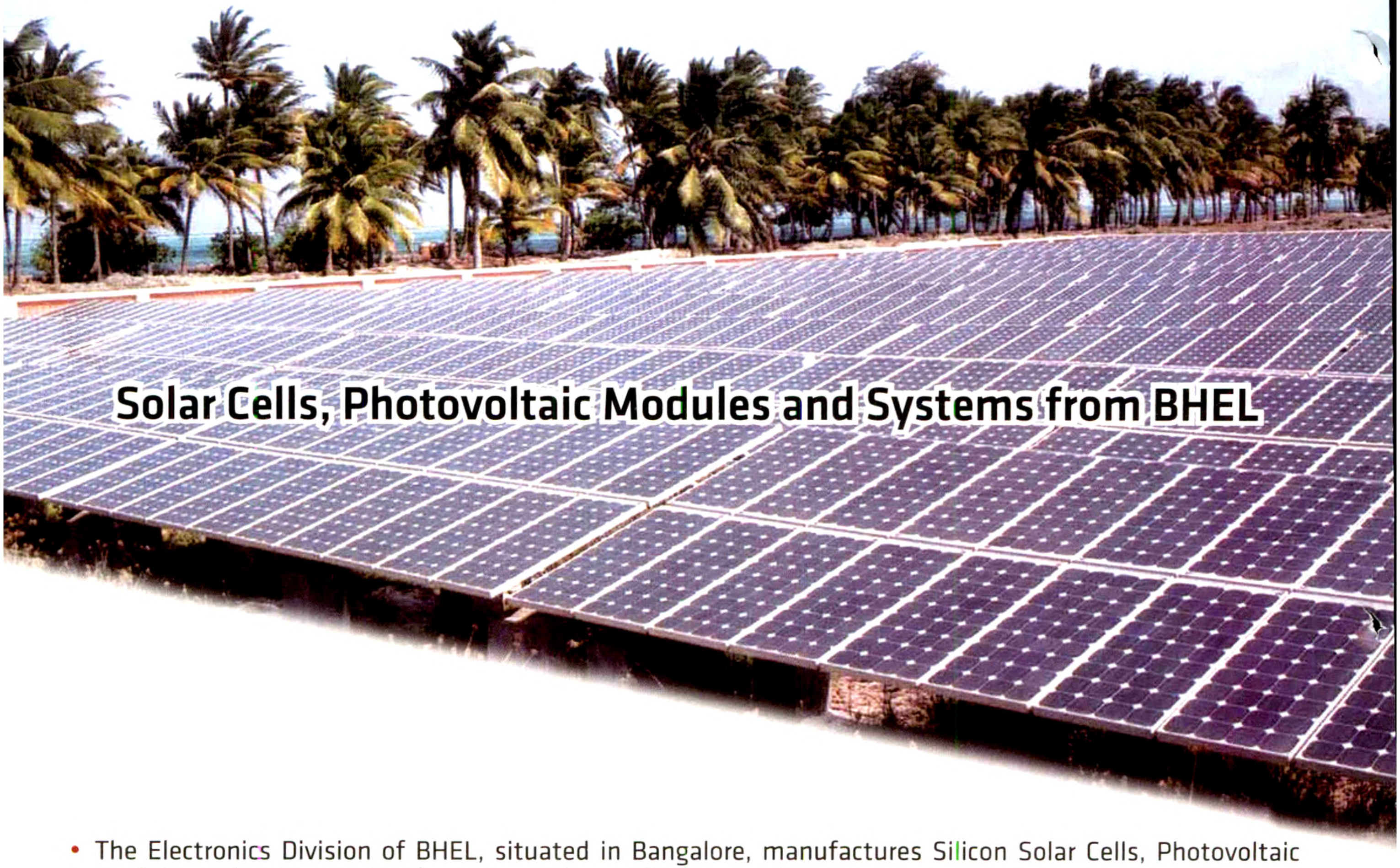
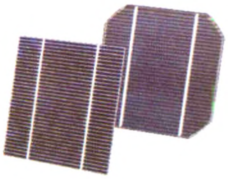


- The Electronics Division of BHEL, situated in Bangalore, manufactures Silicon Solar Cells, Photovoltaic Modules and systems using the state-of-the -art facilities and cutting-edge technology.
- These Photovoltaic Modules are non-polluting, maintenance-free, silent source of energy meeting international quality norms and certified to IEC 61215 standard.
- BHEL conducts site surveys, prepares feasibility reports, offers plant design, erection and commissioning of PV systems and provides after-sales services.



The Product range features:

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Brightening lives.... Powering Progress.

Renewable Energy
Akshay Urja

Volume 3 • Issue 1 ▪ August 2009

A bi-monthly newsletter of the Ministry of New and Renewable Energy, Government of India

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Dear Reader,

India is undergoing a massive real estate development. As a result, huge construction work for buildings, including commercial complexes, residential houses, schools, technical institutions, shopping complexes, and so on, may be seen all around in every city. Many of these buildings have outer coverings of glass for the sake of design, beautification, and modern look, which is quite possibly the replication of the buildings in western countries which have cold climate. However, India has a subtropical climate. Thus, such glass-covered buildings raise the inside temperature, which is often reduced by the use of air-conditioning systems. This is expensive and enhances the electricity demand. There is, thus, an utmost need to adopt the energy-efficient building designs not only to reduce electricity consumption but also to reduce greenhouse gas emissions.

An energy-efficient building would use less energy by utilizing more natural light, relying on passive space conditioning systems for thermal comfort, using energy-efficient lighting fixtures and lamps such as CFLs and T5/T8 tube lights, relying on controls such as occupancy sensors or daylight sensors, and so on. In this scenario, the concept of 'green buildings' is also coming up, but at a slow pace. A green building, besides energy efficiency, also addresses water conservation, water reuse, recycling, rainwater harvesting, waste management, pollution control during construction and operation of the buildings, and so on. A green building ensures minimum energy requirement and minimum negative impact on the environment during its entire life cycle—construction, operation, and eventually, demolition.

NBC (National Building Code), ECBC (Energy Conservation Building Code), and the ratings systems such as LEED (Leadership in Energy and Environmental Design), IGBC (Indian Green Building Council), and GRIHA (Green Rating for Integrated Habitat Assessment), besides solar passive architecture designs, can ensure the design and construction of green buildings. Now the time has come that every new construction should be based on energy-efficient and green building concepts and should ensure maximum utilization of renewable energy as well.

The present issue of *Akshay Urja* concentrates on this concept of 'green' and 'energy-efficient' buildings and contains interesting materials along with articles titled 'sustainable buildings', 'green rating for integrated habitat assessment', 'green building movement in India', and so on. I am sure that our readers will find it informative and interesting.

We sincerely acknowledge the contribution of our writers and are encouraged with the overwhelming response and valuable suggestions from our readers.

Happy reading!

ARUN K TRIPATHI
<aktripathi@nic.in>

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LETTERS TO THE EDITOR

I read *Akshay Urja* regularly. It is extremely good and useful for our college students and staff members, especially that of EEE (Electrical and Electronics Engineering) and ECE (Electronics and Communication Engineering). Thanking you for such a magazine.

B Srinivas
Librarian, Kakinada Institute of
Technology and Science, Thriupathi Village,
Divili, Peddapuram Mandal, E.G.District
Andhra Pradesh–533 433

The article on Greenathon in the April 2009 issue is very impressive. All my thanks to its writer Ambika Shankar for her powerful language and presentation.

I feel, at the moment, solar thermal is more important for rural sector. If it can energize 140 million household chullahs (ovens), the result would be commendable. Huge amount of forest resources (firewood), kerosene, and electrical energy can be saved. It would have tremendous effect in restoring the climatic change. Besides, it can save considerable time for the rural women folk, and prevent fire hazards, eye diseases, and nutrition problems.

I would welcome an investigative article from this writer on 'solar thermal for rural sector'. I would also request all the concerned people, including Honourable Nobel Laureate Dr R K Pachauri, to launch another programme FaBC (firing a billion chullahs/ovens). It can save about 150 trillion units of energy per annum, and ensure energy security and climate protection.

Ramesh Chandra Sahoo,
Senior Electrical Engineer
<ramesh_rec2007@yahoo.co.in>

I am very impressed with the contents of the bi-monthly newsletter *Akshay Urja*. This newsletter provides very important information to scientists, planners, and entrepreneurs on all aspects of renewable energy sources, including biofuels.

There is a caution to all the planners that plantation of biofuel crops should not be done on fertile lands, where our valuable food crops are cultivated. Plantation should be done only wastelands, common Panchayat lands, or any other land that is unproductive. Our country should explore the possibilities of utilizing microorganisms for production of biodiesel. A reddish fungus found in the rain forests of Patagonia region can unlock the biofuel problem in the future. This fungus utilizes cellulose and synthesizes many hydrocarbons of high calorific value—biodiesel (Mycodiesel).

Further there is vast potential for harnessing solar energy, wind energy, and biogas for our rural India.

Atyam Rao
Tanuku
Andhra Pradesh

It gives me great pleasure when I see your magazine that is encouraging the use of non-conventional sources of energy, such as solar energy, wind energy, geothermal energy, biogas, tidal energy, and energy from urban waste. It is the need of today. They are inexpensive and pollution-free in nature. Thanks!

Sanjay Kumar Srivastava
Principal, Vivekanand Modern School,
Fatehpur, Deghat
Almora, Uttarakhand – 263 650

I am a retired Principal Scientist (Microbiology) from Central Arid Zone Research Institute, Jodhpur, and settled in my hometown doing some consultancy work on organic farming, bio-fertilizers, and so on.

I have some suggestions. You can fund some research projects on 'production of hydrocarbons of high calorific value from cellulosic waste using microorganisms' of premier research organizations through the Department of Biotechnology or ICAR (Indian Council of Agricultural Research). There is a vast scope in this field of research, and get quick results of high economic value.

Dr A V Rao
Sajjapuram, Tanuku
Andhra Pradesh – 534 211

While studying the magazine, it is understood that the Ministry of New and Renewable Energy is doing a lot of developments in renewable energy. The list of BIS (Bureau of Indian Standards)-certified manufacturers of solar cookers in the February 2009 issue was a very useful article. Heartfelt thanks to the team members for providing information that will benefit and develop the agricultural community. I can distribute the magazine to the schools in Coimbatore, as many are encouraging the students to submit project reports on global warming, solid waste management, environment conservation, use of solar and wind power, and so on.

V Rameshbabu
'Anugraha',
Veerkeralam, Coimbatore – 641 007

Dear Reader,

Thank you very much for your encouragement. The editorial team of *Akshay Urja* will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvement in terms of content and presentation.

Editor
Akshay Urja

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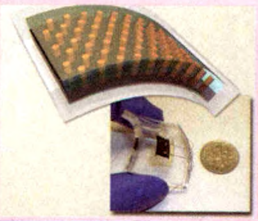

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RAJIV GANDHI AKSHAY URJA

The Ministry of New and Renewable Energy has been promoting various initiatives and technological innovations to successfully utilize renewal energy sources such as solar, wind, hydropower, biomass, and urban and industrial waste. An effective and widespread mass awareness campaign on renewable energy is organized as the 'Rajiv Gandhi Akshay Urja Diwas' across the country on the 20th of August every year. It commemorates the birth anniversary of former Prime Minister Rajiv Gandhi—a man who envisioned providing electricity to all rural and remote areas of the country. And power for all cannot be achieved without using the full potential of new and renewable energy sources.

This year, too, the Akshay Urja Diwas was celebrated with great zeal and enthusiasm. The national-level function was held in Jaipur, Rajasthan, with Dr Farooq Abdullah, Union Minister for New and Renewable Energy, and the Chief Minister of Rajasthan, Shri Ashok Gehlot, and other dignitaries. The day was simultaneously celebrated throughout the country, with the financial support from the MNRE (Ministry of New and Renewable Energy) of Rs 1.5 lakh for each district. The programmes primarily consisted of awareness campaigns; mobile exhibition vans in several states; renewable energy

DIWAS 2009 CELEBRATED...

quiz in Hindi, English, other regional languages, drawing, poster-making, and debate competitions for students; and radio sponsored programmes for various renewable energy technologies in Hindi, English, and other regional languages, which were broadcasted in main/local channels of All India Radio.

The national function commenced with the Rajiv Gandhi Akshay Urja Run, which were flagged off by Dr Abdullah and Shri Gehlot. A large number of athletes, students, and citizens participated in the different categories of the run. The winners were awarded at the main function at Birla Auditorium. The half marathon of 21 km was won by Sandeep Kumar and the 16 km run for women from Amar Jawan Jyoti was won by Kavita Rout. They were awarded a cash prize of Rs 51 000 each. The runner-ups won cash prizes of Rs 31 000 and Rs 21 000 in each category.

Apart from the prize distribution ceremony for the winners of the run and other competitions, the main function offered various attractions, including a laser show on the use of renewable energy and an exhibition of renewable energy devices and power plants. Also, Shri Gehlot and Dr Abdullah administered the Akshay Urja Pledge to the gathering. The function was also attended by Shri Deepak Gupta, Secretary of MNRE; Shri Mahadev Singh Khandela, Minister of State for Road Transport and Highways; Shri Jitender Singh, energy minister of Rajasthan government; and Smt. Kaushal Singh, Chief Secretary of Rajasthan government.

Dr Abdullah stressed the need for the use of renewable and non-conventional energy sources and listed out various initiatives and activities undertaken by his ministries. He informed that the Center is planning to set up a solar power project of about 3000–5000 MW (mega watt) in coordination with the Rajasthan government. He has promised electricity to all the villages in Rajasthan in the next five years from non-conventional energy sources. He said an action plan would be formulated to achieve this end. 'With its rich resources of solar and wind energy, Rajasthan should show the path to the rest of the country in power production in the non-conventional sector', said Dr Abdullah. And hopefully, India would soon become the world leader in this sector.

SOLAR MISSION GETS A NOD

The Solar Mission, under the National Action Plan on Climate Change, has received an in-principle nod from the Prime Minister of India with an ambitious target of 20 000 MW solar power by 2020. The Mission aims to promote the development and use of solar energy for power generation and other uses, with the ultimate objective of making solar energy competitive with fossil-based energy options.

The Mission envisages fiscal incentives, including a 10-year tax holiday for solar plants, both photovoltaic and thermal, set up by 2020, and exemption from customs and excise duties on specific capital equipment, critical materials, and project imports. It also proposes to impose a 'small cess' on all fossil fuels at the rate of Rs 0.20 per 10 000 Kcal to meet the requirement of the funds. International funding may also be sought for various components of the Mission.

The Mission proposes the extension of the current offer of five-year loans at 2% interest for solar thermal water heaters for domestic use and 3%-5% interest loans to install off-grid solar PV (photovoltaic) lighting systems for institutional and commercial use. A number of similar fiscal incentives and interest rate subsidies are also envisaged to promote solar manufacturing, in addition to the SIP (Special Incentive Package) for the setting up of an integrated solar manufacturing plant.

The Mission envisages an investment of Rs 91 684 crore over the next 30 years. This will include an interest subsidy to the tune of Rs 7300 crore. It proposes to add 20 000 MW of power by 2020 and 100 000 MW by 2030. To unfold in three phases, it aims to achieve parity with coal-based thermal power generation by 2030. In the first phase of implementation (2009-12), a sum of Rs 10 130 crore would be required. The monetary requirement would be Rs 22 515 crore and Rs 11 921 crore in the second (2012–17) and third (2017–20) phases of implementation, respectively.

However, in a meeting that lasted over two hours, the Climate Change Council headed by the PM (prime minister) suggested several changes and alterations to the mission details, which will now be incorporated in the final document. Institutional framework and costs were some of the key issues that were raised by council members and involved ministries. A more realistic cost of the programme has been suggested to correct the projections after the achievement of grid-parity for solar power.

The PM's council recommended that the character of the mission be altered to make it more regulatory in character than one that provides subsidy to solar power manufacturers and generators. It was also pointed out that the draft document had paid little attention to solar-thermal and focussed more towards photovoltaic. Council members recommended that the mission should give higher weightage to solar-thermal because India has a manufacturing base in solar-thermal and the possibilities of cost reduction are higher in it.

It was also decided to build a special focus on research and development, which was missing till date in the proposed Solar Mission. Other members stated that while keeping an 'ambitious' target, the Solar Mission should be built within an 'enabling framework' emerging from international negotiations. It would be important to demand technological and financial support from the international community under the United Nations negotiations for such a huge target for clean energies due to the uncertainty of the costs.

Issues were also raised about the institutional framework recommended, which comprises of a commission along the lines of the Atomic Energy Regulatory Commission and an authority to carry out implementation. Concerns about the weakness in the atomic commission as well as the wind-power generation system were also raised.

www.indiatimes.timesofindia.com

Nanopillars promise cheap, efficient, flexible solar cells

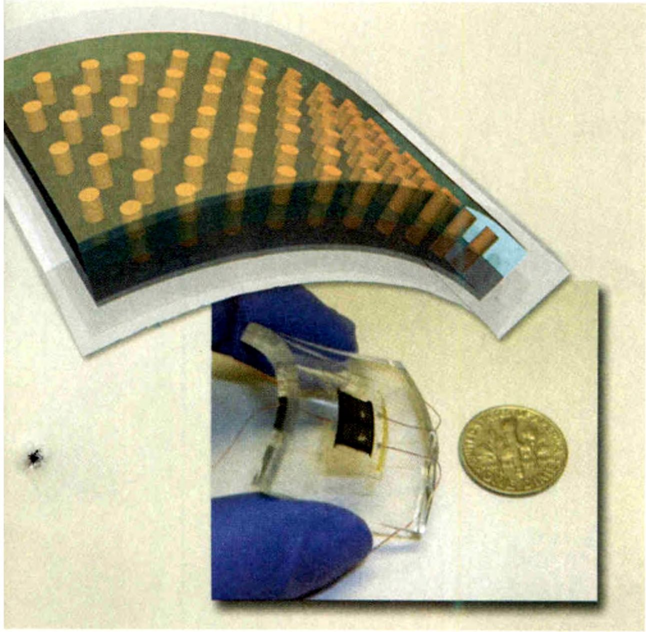
Researchers at the Lawrence Berkeley National Laboratory, US (United States) Department of Energy, and the University of California at Berkeley have demonstrated a way to fabricate efficient solar cells from low-cost and flexible materials. The new design grows optically active semiconductors in arrays of nanoscale pillars, each a single crystal, with dimensions measured in billionths of a metre.

A solar cell's basic job is to convert light energy into charge-carrying electrons and 'holes' (the absence of an electron), which flow to electrodes to produce a current. Unlike a typical two-dimensional solar cell, a nanopillar array offers much more surface for collecting light. Computer simulations have indicated that compared to flat surfaces, nanopillar semiconductor arrays are more sensitive to light, have a greatly enhanced ability to separate electrons from holes, and be a more efficient collector of these charge carriers.

'To take advantage of abundant solar energy, we have to find ways to mass-produce efficient photovoltaics,' says Ali Javey, faculty scientist at Berkeley Lab's Materials Sciences Division and professor of electrical engineering and computer science at UC Berkeley. 'Single-crystalline semiconductors offer a lot of promise, but standard ways of making them are not economical,' he adds.

'Epitaxial growth on single crystalline substrates was often used, which is costly. The nanopillar dimensions were not well-controlled, pillar density and alignment was poor, and the quality of the interface between the semiconductors was poor.'

Javey devised a new, controlled way to use a method called the 'vapour-liquid-solid' process to make large-scale modules of dense, highly ordered arrays of single-crystal nanopillars. Inside a quartz furnace his group grew pillars of electron-rich cadmium sulphide on aluminium foil, in which geometrically distributed pores made by anodization served as a template. Then, they submerged the nanopillars in the furnace. Once grown, in a thin layer of hole-rich cadmium telluride, they acted as a window to collect the light. The two materials, in contact with each other, form a solar cell in which the electrons flow through the nanopillars to the aluminium contact below, and the holes are conducted to thin copper-gold electrodes placed on the surface of the window above.



The efficiency of the test device was measured at 6%, which while less than the 10% to 18% range of mass-produced commercial cells, is higher than most photovoltaic devices based on nanostructured materials—even though the nontransparent copper-gold electrodes on top of the Javey group's test device cut its efficiency by 50%. In future, top contact transparency can easily be improved.

Concerned with practical applications as well as theoretical performance, the researchers made a flexible solar cell of the same design by etching away the aluminium substrate and substituting a thin layer of indium for the bottom electrode. They sheathed the whole solar cell in clear plastic (polydimethylsiloxane) to make a bendable device, which could be flexed with only marginal effect on performance. And there was no degradation of performance after repeated bending.

This work was supported in part by the Helios Solar Energy Research Center, which is supported by the US Department of Energy's Office of Science, Office of Basic Energy Sciences.

WWW.SCIENCEDAILY.COM

The 2008 Wind Technologies Market Report released

The United States Department of Energy has recently released its '2008 Wind Technologies Market Report'. The report analyses a range of developments in the wind market, including trends in wind project installations, turbine size, turbine prices, wind project costs, project performance, and wind power prices. The report also details trends in project financing – a key concern for the wind industry in the current economic climate – as well as trends in project ownership, public policy, and the integration of wind power into the electrical grid. The report provides the wind industry, state and local policy makers, and the general public with valuable information on the state of wind power in the US (United States).

The reports states that the US continues to lead the world in annual capacity growth and overtook Germany to take the lead in cumulative wind capacity. For the fourth straight year, the US led the world in wind capacity additions, capturing roughly 30% of the worldwide market. The cumulative wind capacity installed in the US at the end of 2008 would, in an average year, be able to supply roughly 1.9% of the nation's electricity consumption.

Soaring demand for wind has spurred expansion of wind turbine manufacturing in the US. As a result, the American Wind Energy Association estimates that the share of domestically manufactured wind turbine components has grown from less than 30% in 2005 to roughly 50% in 2008, and that roughly 8400 new domestic manufacturing jobs were added in the wind sector in 2008 alone.

Texas led all states with 7118 MW (megawatt) of total wind capacity installed, followed by Iowa (2791 MW) and California (2517 MW). Seven states now have more than 1000 MW installed, and 13 have more than 500 MW. Iowa and Minnesota have the highest levels of wind penetration (in-state wind generation as a percentage of all in-state generation). Seven states have wind penetration levels greater than 5%, and six utilities have in excess of 10% wind on their systems.

Wind power remained competitive in wholesale power markets in 2008, with average wind power prices at or below the low end of the wholesale power market price range. However, an upward pressure on wind power prices is set to continue.

WWW.NREL.GOV

Students design more efficient, affordable solar lighting for Sub-Saharan Africans

A Kansas State University student is combining engineering and nature to design a more affordable and more sustainable lighting source for those living without electricity.

Tai-Wen Ko, K-State senior in electrical engineering, and Justin Curry, K-State freshman in electrical engineering, are designing a solar lantern with a more affordable initial cost. Ko is focusing his efforts on people living in Sub-Saharan Africa, which is the least electrified region in the world.

Kerosene lamps are the most affordable option for people without electricity. But, the lamps can be expensive to maintain, and they produce carbon dioxide, which contributes to global warming. Solar lanterns are a popular alternative to kerosene lamps because they run on renewable energy and do not have the risk of starting a fire.

'Solar lanterns are not hard to make,' says Ko. 'You have to find the right parts and have ideas on how to build a circuit. I wanted to make a design that would be easy enough for someone living in Sub-Saharan Africa to build on their own, which would lower the cost because they would not have to have it shipped.'

The solar lantern has three main components—a solar panel, a battery, and a white light-emitting diode. He researched different types of these materials and chose the cheapest options. Ko's lantern is about 30% cheaper than the average market value.

Most available solar lanterns use florescent tubes, which draw

a lot of power. He decided to use a white light-emitting diode because it is cheaper, lasts longer, and is brighter. He chose the cheapest option for solar panel and battery. The battery is a sealed lead-acid battery, similar to a car battery.

Ko says an environmental concern for his lantern is that the battery contains lead. A lithium ion battery would be better for the environment, but its current cost is expensive. So, he is researching a recycling plan that could be implemented in the Sub-Saharan African regions.

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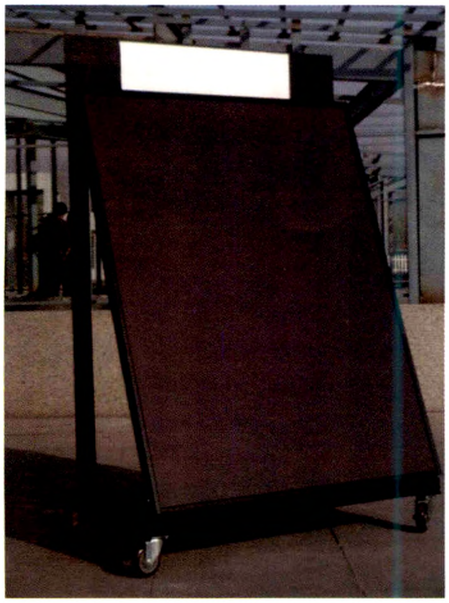
New generation of solar cells promises efficiency

The laboratory for photovoltaics of the University of Luxembourg has produced its first thin film solar cells made from compound semiconductors, already reaching a 12% efficiency. Thin film solar cells are considered the next generation of solar cells and are expected to be considerably cheaper because they need much less material and energy in their production than today's photovoltaic modules. The solar cells made in Luxembourg are based on a semiconductor made of CIGS (copper, indium, gallium, and selenium) and made by a process with the potential for highest performance. Furthermore, the university scientists produced another solar cell based on a new cheaper material, which does not contain the costly indium, and made by a low-cost galvanic process. This solar cell has reached an efficiency of 3.2%. This is already close to the world record—the best cell based on this new material and prepared by a similar low-cost process shows an efficiency of 3.4%.



'Currently, we can produce the heart of the solar cells, the so-called absorber layer and the buffer. But, for completing the solar cells, we rely on the help of our colleagues from Helmholtz-Zentrum Berlin', says Professor Susanne Siebentritt, Head of the laboratory. The laboratory focuses not only on the development of solar cells but also on furthering the physical understanding of the materials and interfaces involved in these solar cells.

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Mines could provide geothermal energy

Mine shafts on the point of being closed down could be used to provide geothermal energy to local towns, say two engineers from the University of Oviedo in Asturias, Spain. They have a developed a method by which it would be possible to estimate the amount of heat that a tunnel could potentially provide.

'One way of making use of low-intensity geothermal energy is to convert mine shafts into geothermal boilers, which could provide heating and hot water for people living nearby', says Rafael Rodríguez from the Oviedo Higher Technical School of Mining Engineering. This type of energy, which is hardly used in Spain, is obtained from the internal heat of the Earth.

The engineer and his colleague María Belarmina Díaz have developed a 'semi-empirical' method (part mathematical and part experimental) to calculate the amount of heat that could be produced by a mine tunnel, which is due to be abandoned, based on studies carried out while it is still in use.

'When the mine is still active, one can access the tunnels easily in order to gather data about ventilation and the properties of the rocks, as well as to take samples and design better circuits, and even programme the closure of some sections in order to use them for geothermal energy production', says the engineer. He stresses that although geothermal energy can be made use of once the mine is closed, 'it is no longer possible by that stage to make any modifications, or to gather any useful data to evaluate and improve the system'.

The study looks into geothermal exploitation of a 2-km-long mine shaft, in which the temperature of the rocks 500m below the surface is around 30 °C. This is typical of many of the mining areas in Asturias, although it could also be applied to other parts of the world. Water could be forced in through tubes at 7 °C and return at 12 °C—a big enough heat gain to be of benefit to towns located above the mines.

According to Rodríguez and Díaz, there are a number of benefits of building geothermal boilers in mine shafts. Apart from their predictable energy production levels, they also function practically as an open tube system 'but without any risk of heat contamination of aquifers'. Using geothermal energy also helps to reduce carbon dioxide emissions, and is not dependent upon climatic conditions, unlike other renewable energies like

solar and wind power. Also, these facilities make use of a country's own resources, do not require new developments on large sites, do not pollute the immediate environment, and are believed to be profitable over the long term.

WWW.EUREKALERT.ORG

World's second-largest solar thermal power plant to be built in Florida, US

By mid-2010, FPL (Florida Power and Light) will construct the Martin Next Generation Solar Energy Centre—a 75 MW (megawatt) plant. The plant is both the world's first hybrid energy facility and the largest solar plant of any kind outside of California, US. It will sit on 500 acres near Indiantown, Florida, adjacent to FPL's existing combined-cycle power plant. Two other solar facilities have homes in Florida—one at the Kennedy Space Center at NASA (National Aeronautics and Space Administration) and the other in DeSoto County. Together with the new plant, they will produce 110 MW of electric power.

The parabolic trough system with about 180 000 mirrors will provide 155 000 MWh of electricity annually. The plant does not include energy storage, so electricity will only be generated during daylight hours. Construction costs are estimated between $550 and $600 million. The plant was contracted by Lauren Engineers and Constructors, an Abilene-based company which also built the 64 MW Nevada Solar One plant in Boulder City, Nevada. More than 1000 people will work on the project and Lauren expects more jobs to open in Abilene as a result of the Florida solar plant development.

By adding this solar plant, Florida expects to reduce its greenhouse gas emissions by 2.75 million tonnes over 30 years, which is the equivalent of removing 18 700 cars from the road annually for the life of the plant. 'Florida's future growth and economic strength depends on how we address climate change, and we know we can reduce greenhouse gases by using fewer fossil fuels and more natural energy sources like solar…[The Martin Next-Generation Solar Energy Center] is a significant step in that direction,' says Florida's Governor Charlie Crist.

WWW.NREL.GOV

New study says US leads world in geothermal energy production

The US (United States) leads the world in online geothermal energy capacity and is one of the main countries that will increase its capacity, according to a report by the US Geothermal Energy Association. Geothermal power was being generated in eight states—Alaska, California, Hawaii, Idaho, Nevada, New Mexico, Utah, and Wyoming. Other states are soon to be added, including Oregon, Colorado, Florida, Louisiana, and Mississippi.

California and Nevada are the leading states in developing geothermal energy, and make up almost 97% of currently active geothermal power capacity. Their nearest competitor is Utah and they outpace it 65-fold.

The combined confirmed and unconfirmed capacity under development in Nevada could end up being 3373.4 MW (megawatt), or 7.5 times its current capacity. California has up to 2435.8 MW in development. In 2005, California's geothermal capacity exceeded that of every country!

In 2007, geothermal energy was 4% of renewable energy consumption in the US. And it is set to increase more than threefold. As of September 2009, it was 3152 MW with 6442.9 MW of new capacity under development. Unconfirmed projects could increase new capacity to 7109.9 MW.

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RASHTRAPATI BHAVAN GOES GREEN

The Rashtrapati Bhavan has become 'green' by adopting a host of environment-friendly initiatives in the estate, including the installation of 100 solar-powered streetlights and a biogas plant. These 'green' programmes have been executed under the project titled 'Roshini', which was launched in July 2008 by the Hon'ble President of India Smt. Pratibha Devisingh Patil to make the Bhavan a model urban township that cares for the environment.

There are several other major plans, which would soon be implemented as part of the project. These include a waste management and recycling programme, launching of a 'nature trail', ban on plastic bags, rainwater harvesting, and the installation of a STP (sewage treatment plant) that is being overseen by an advisory committee and a project implementation and monitoring group. The STP, being set up in consultation with IIT (Indian Institute of Technology)–Delhi, will convert all the used water flowing out of the Rashtrapati Bhavan into reusable water for horticulture purposes. The treated water will be used in the 14 gardens of the Estate. Pegged at Rs 86.9 million, the work for setting up the STP will be completed in about six months. On the completion of these initiatives, the Rashtrapati Bhavan will apply for ISO (International Organization for Standardization) certification.

The main aim is to convert the Rashtrapati Bhavan into a zero-waste model township to illustrate India as a model in green initiatives. But, there are several other added advantages. The primary one is, of course, the contribution towards combating climate change and environmental degradation. Other benefits include reduction in consumption of conventional fuels, increase in savings, reduction in waste generation, and increased self-dependency. The installation of solar lights has helped to reduce electricity consumption, which would save around Rs 0.35 million per annum. The 25 cu^3 biogas plant, on the other hand, would save fuel to the tune of Rs 1.12 lakh per annum. The plant would also produce manure worth Rs 80 000 every year. According to Rashtrapati Bhavan officials, Rs 4–5 lakh were earlier spent annually on buying manure that was not necessarily eco-friendly. But now, the manure from the biogas plant can be used.

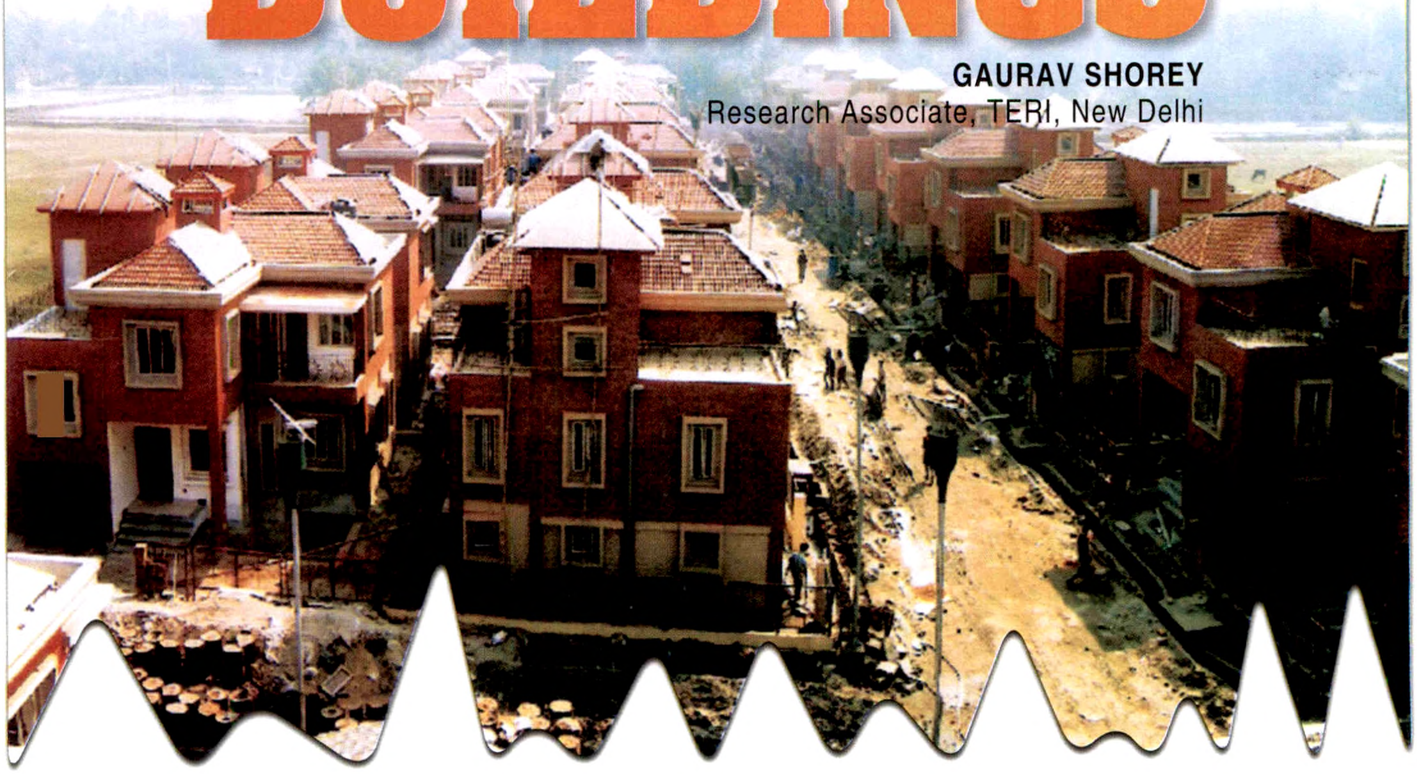
Other green initiatives include a solar photovoltaic power plant of 50 KW_p capacity and a solar-heated swimming pool.

For the successful implementation of Project Roshini, the President's Estate Residents Welfare Association is actively involved in activities, such as recycling of waste paper and formation of self-help groups. The expertise of a number of institutes were taken for the project's implementation.

Dr Farooq Abdullah, Union Minister for New and Renewable Energy, informing the President of India, Smt. Pratibha Devisingh Patil, about the benefits of solar plants in Ladakh.

SUSTAINABLE BUILDINGS

GAURAV SHOREY
Research Associate, TERI, New Delhi



Real estate development is the star industry for many an economy in countries around the world—a business with very high returns, especially for those who play their cards right.

With nearly every big industrialist vying for a piece of the pie, no one has the time or the inclination to assess the demands and the resultant stress that the buildings being built during the boom have on the environment. In fact, most people fail to acknowledge the connection between buildings and the environment, due to the common error in trivializing the 'environment' down to 'plants, trees, and general greenery'. This disconnection has now resulted in buildings being the single biggest threat to the environment as we know it, both directly as well as indirectly.

The life-cycle of a building

If we examine the prevalent trend, we would arrive at the following pattern:

- Valuable land (often forested and agricultural) is used for construction
- Flora and fauna, which are part of the ecological balance of a region, are cleared off to accommodate buildings—may it be in the wetlands of Kolkata, the farm lands of Delhi, the forest lands of Nagaland, or the coastal reserves of Goa.
- Fertile soil is excavated and wastefully dumped as far away from the site as possible.
- For building materials
  - Soil (often very fertile) is used to manufacture burnt clay bricks. Often, entire hills are blasted through for stone.
  - Hundreds of acres of hills and forest areas are mined for iron ore, bauxite, and other such materials to manufacture steel for reinforcements, grilles, aluminium sections for frames, structural glazing, and so on.
  - Trees are cut for wood work, and to make door and window frames and furniture.

- Water bodies are polluted due to effluent discharge from plastic and paint factories.

Once the building is up and running, it has an endless requirement for energy and water, so

- Forest areas are reduced to vast deserts for coal extraction to fuel power plants.
- These power plants then supply power to buildings as well as industries that directly or indirectly cater to buildings.
- Power is also supplied to run city civic amenities such as street lights, water pumps, mass rapid transport lines, and sewage treatment plants.

However, the indirect impact of the building is what is often ignored. For instance, the location of your home will often dictate your choice of clothes, consumer durables, vehicle, food, and fast-moving-consumer-goods. Many of these items would have to be imported, which would also have a negative ecological impact.

All of the above lead to a singular end—waste generation. A building produces solid waste, which includes organic waste, e-waste, chemical waste, recyclable waste, non-recyclable waste, and sewage, and liquid waste such as sullage. Most cities in India have poor waste management strategies and most of the waste is dumped in open landfills, which leads to severe pollution and contamination of the groundwater aquifer due to leachate, or allowed to drain into the nearest water bodies such as rivers, lakes, and seas.

So, one is left with some pressing questions, such as

- How long do we keep looking for more land for newer landfill sites?
- How long do we keep constructing more power plants at the cost of relocating and destroying the livelihoods of millions of rural people?
- How long do we keep redirecting power to large, energy-guzzling cities at the cost of supplying power to smaller towns and villages—the very villages that supply food produce to our cities?

Green vs sustainable vs energy-efficient buildings

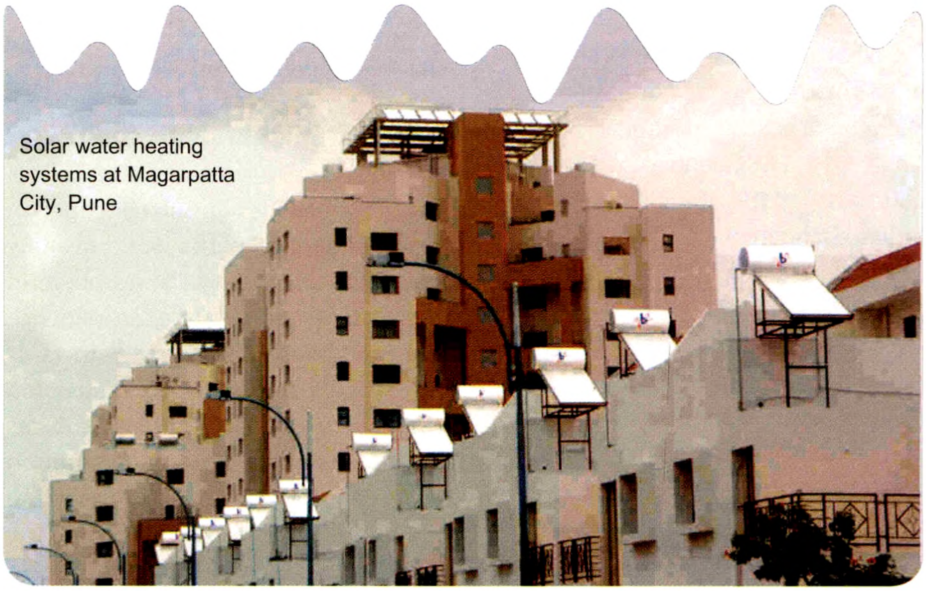
Given the extensive list of areas that are affected by buildings, one commonly hears loosely thrown around terms related to the environmental sensitivity of buildings. These include 'energy-efficient' buildings, 'green buildings', and 'sustainable habitats'. So before we delve into the semantics, let us briefly try and understand the differences between these types of buildings.

Energy-efficient buildings

Energy-efficient buildings are those that help conserve the key resource that drives our lives today—energy. Energy, as mentioned earlier, is mainly used to power electrical equipment such as lights, fans, and space conditioning systems. These constitute the areas of largest energy consumption in a building. A whole host of other components, such as computers, televisions, music systems, heaters, and cell phones also consume energy. But, their use is periodic and varies from income-group to income-group.

So essentially, an energy-efficient building would use less energy through the following measures:

- Relying on natural light for its visual comfort requirements
- Relying on good architecture and passive space conditioning systems for thermal comfort requirements
- Relying on energy-efficient lighting fixtures and lamps, such as CFLs (compact fluorescent lamps) and T5/T8 tube lights for artificial lighting
- Relying on energy-efficient space conditioning systems like evaporative coolers, high COP (coefficient of performance) chillers, variable frequency drives in all motors, pumps, and fans, and double skin AHUs (air handling units), and so on.
- Relying on controls, such as occupancy sensors (that turn electrical equipment on/off depending on the occupancy of an area) or daylight sensors (that turn lights on/off depending on the availability of sun light in an area).



Solar water heating systems at Magarpatta City, Pune

Seeing the lack of energy efficiency in buildings, the Indian government released the ECBC (Energy Conservation Building Code) that put forth requisite specifications for building materials and systems so that the end product (the building) is assuredly energy-efficient.

But, all the above measures certainly do not address other areas such as water, waste, biodiversity, human rights, and so on. So, for those issues we have 'green buildings'.

Green Buildings

A 'green building' would address aspects that go beyond mere energy efficiency—water use reduction (within the building and in the external landscape), water reuse, recycling, rainwater harvesting, landscaping using native species of plantss, waste management strategies, pollution control during construction and operation of the building, and so on. This would involve a more holistic approach to building design, engineering, construction, and management/operation.

A 'green building' shall ensure that it has minimum energy requirement, as well as a minimum negative impact on the environment during its entire life cycle, that is from design through construction to operation and eventually, demolition.

What is interesting to note is that India's national codes and standards, such as the NBC (National Building Code), the ECBC, and other relevant codes issued by the BIS (Bureau of Indian Standards), can help to design and build a 'green building'.

A sustainable building

A 'green building' would achieve exalted status if its objective did not stop at reducing its demand (for energy and water) alone, but also looked at catering to its own supply. So, a truly sustainable building would go through the entire exercise of becoming energy-efficient, becoming 'green', and then go further by relying on renewable sources of energy and water so that its dependence on conventional sources of the same is virtually eliminated.

In utopian conditions, it could go a step further to address on-site food generation, socio-cultural infrastructure, livelihoods, and so on so that the community inhabiting the buildings is almost entirely self-sustaining.

How do rating systems fit in?

Rating systems have been a popular tool of mainstream design and construction of 'green buildings' the world over. By creating a competitive atmosphere in the building industry, one can influence the key stakeholders to strive towards increasingly efficient buildings (on the energy as well as other resources fronts). A formal recognition through an established entity gives them the right edge over the competition in the market other than the obvious benefits of reduced operational cost (due to the reduction in energy and resource consumption), increased occupant comfort, higher productivity, and so on.

Green buildings in india

India has always had the most sustainable practices possible in the building sector. Apart from the recent trends and changes in people's perceptions towards what constitutes building 'aesthetics', we have always had excellent buildings in our country.

In fact, we have a legacy of more than a thousand years of historic architecture that stand as excellent examples of low-energy buildings till date. Then, how is it that a frivolous western trend of erecting glass towers has suddenly become 'the' acceptable standard for architectural designs in India? Are we to believe a 10–15-year-old trend or thousands of years of wisdom that tells us otherwise?

This is the primary driver that has given rise to initiatives such as ECBC,

rating systems, and environmental clearances. Because in their absence, the building sector in India would be single-handedly capable of becoming the largest energy consuming sector!

GRIHA as a means to an end

With sustainable habitats as the end, among the more recognized ways of achieving sustainability in building design is through the rating system approach. This is because the multitude of professions that interface with buildings make it difficult for any one person to grasp all the requirements.

So, avoiding the obvious pitfalls of trivializing the system down to a perfunctory check-list, wherein many points serve no regional/local context, TERI (The Energy and Resources Institute) developed the GRIHA (Green Rating for Integrated Habitat Assessment) rating system.

The system attempts to give due weightage and importance to as many parameters (that are locally relevant) as possible so as to end up with a sustainable building. The system also tried to address the issue of managing multiple codes and standards, which exist in the Indian building sector, by taking key inputs from the various codes and stringing them in a manner that would facilitate the achievement of the goal with ease.

One also needed to bear in mind that India has prioritized national concerns such as power shortages, water shortages, waste management, and labour management. These were the key areas that TERI felt needed attention so as to secure India's energy and resource future through better buildings.

Unique India

India is unique in that the kind of power and water crisis situations that exist here are not common to the developed countries, particularly the West where most rating systems exist. Also, all rating systems (and appreciatively so) try to give an impetus to their country's industries and trades. So, it was necessary to for GRIHA to give an impetus to Indian industries.

In addition, India lies in distinctly different climate zones and is also a mega biodiverse country, unlike most of the developed nations which lie in northern latitudes where the flora and fauna is limited due to the extreme cold. So, we have diametrically opposite concerns and a lot more to loose if we destroy our resources blindly.

We also have a rich architectural heritage that has sustained from 3000 BC (Harappa and Mohenjodaro), which have shown us how best to build in our kind of climate and which we have ignored to the point of obliteration in the recent past.

GRIHA

The Green Rating for Integrated Habitat Assessment has been very aptly abbreviated into 'GRIHA', as the Sanskrit word means 'abode', regardless of what it is an abode for, a family or a business or sick people or higher education.

In a nutshell, it addresses all the external and internal environmental concerns that impact a building or rather, that are impacted by buildings. It goes without saying that the concerns are largely what we experience in India and not what concerns the West.

It is structured to address every step taken during the design, construction, and occupation process of a building.

Conventional approach

- Client decides to build a project and identifies a site for it. He/she purchases a site that may even be in the middle of a forest.
- Without much concern over what surrounds it, or what role the larger land area plays, the entire site is cleared off its trees and fertile top soil to make way for car parking, jogging tracks, ans so on.
- The site is excavated without any concern about the season of the construction activity. If it rains, there are major time and cost overruns, not to mention wastage of materials and soil erosion.
- Utility lines are laid out in a haphazard manner. Such situations always lead to constant excavation and reconstruction of roads and pathways. This is a common phenomenon in many areas of Delhi. The water services department digs up the road and lays a pipe, then the road is repaired. Soon after, the telephone services people dig up the road and the road is again repaired. Then, the sewage pipe develops a leak and the road needs to be dug up again! And the story continues. If all utilities are organized from the start, such situations can be avoided with ease.

- The architect designs a conventional building, without taking into account climate sensitivity and passive design, which nearly guarantees that the building will always have a high energy requirement whether for artificial lighting or space conditioning.
- All other consultants put in mechanical, electrical, and plumbing equipment based largely on thumb rules, with high factors of safety to take into account erroneous execution. This leads to excess material consumption.
- Labour is brought onto the site and kept in inhuman conditions, with barely any safety or sanitation facilities provided to them. This obviously has an impact on the quality of construction and finishing, which is generally very poor.
- Conventional materials are selected, which damage the environment either during manufacturing or during use. They also have an impact on the energy consumption of the building. For instance, a glass building will always have a higher energy demand than that of a brick and glass building.
- The construction technologies are also sub-optimal. The speed of construction is slow due to lack of appropriate technologies being adopted, which again leads to cost and time overruns.
- Once the building is constructed, water and solid waste management is left to the civic bodies to manage.
- Large sums of money are spent on back-up diesel generator sets that consume hundreds of litres of diesel every day to cater to the power requirements during power cuts.

This process has a negative impact on the environment over the entire life cycle of a building, which may be 50 to 100 years.

The GRIHA approach

- The client has to select a site that is within Master Plan limits and conforms to UDPFI (Urban Development Plans Formulation and Implementation) guidelines. The site must also be within half a kilometre distance from key amenities such as banks, place of worship, grocery shops, public transport terminals/bus stops/metro halts, and the likes. The reason for this is that buildings are often constructed (they may be energy-efficient in terms of design) such that people have to drive long distances to get to and from there. So, on one side we save electricity, we spend thousands on fuel.
- Trees are protected on site. As far as possible, they are preserved, protected, or transplanted. And even if the trees are cut, trees of the same species are planted in a '1:3 ratio'—3 planted for each tree cut.
- Top soil is preserved so that it can be reused for landscape development.
- Construction activities (major civil works and structure) are organized in a manner that they are completed before the rains, so that activities like interior works and finishing can be carried out during the rains.
- All utilities are located in designated utility corridors that are easily accessible and are positioned right next to the vehicular/pedestrian pathways, so that no excavation or digging is required at a later date for repairs.

TERI RETREAT, Gual Pahari, Gurgaon

- Labour is brought onto the site and provided good safety, health, and sanitation conditions. This ensures that they put in their best effort into the construction activities.
- The architect designs the building in coordination with the energy consultant and follows all climate responsive strategies, such as
  - Solar path analysis to ensure that the building orientation is perfect.
  - Minimal glazed areas on the side of extensive solar radiation.
  - Optimal window to wall ratio (that is not having a 100% glazed façade).
  - Ensuring the building openings are designed to allow the natural winds to flow through the building.
  - Shading analysis to cut down on expenditure on high-performance glass. Lower performance glass, if used with shading strategies such as canopies and verandahs, can work just as well as very high performance glass without shading. However, very high performance glass also has a very high cost attached to it.
  - Materials are selected carefully, such that they are available locally and not too much energy is wasted on their manufacturing as well as transportation.
  - Constant coordination and interaction is maintained with all other consultants so that they agree with the architect's recommendations and are not struggling with making trivial corrections at a later date.
- The construction is carried out in a systematic manner and materials are stored carefully on the site. No material is wasted and all the waste products are safely discarded. For instance,
  - The site would be barricaded so that air borne pollution does not affect the people around.
  - The site would have a sedimentation basin or a pit to catch any water that may collect on site, especially during rains. This ensures that no water borne pollutants leak into the aquifer or the surrounding sites.
- The energy systems, such as lighting and space conditioning, are designed after first considering all the natural options available such as natural light and natural ventilation.
  - The system is designed in an optimal way so as to minimize the system size and save capital cost, as well as minimize the operational energy use and the operational cost (electricity bills).
- Electrical systems, such as cabling, transformers, and generator sets, are also downsized because the demand of the building is reduced from the above exercise.
- Water demand of the building is reduced through water-efficient fixtures such as taps, urinals, water closets, and the likes.
- External water demand is minimized by planting native species of trees and shrubs, and installing efficient irrigation systems.
- Other means of catering to the energy demand of the building, such as renewable energy technologies, are employed wherever possible.
  - Solar thermal systems are used to cater to the building's hot water demand.
  - Solar photovoltaic systems are used to cater to the building's energy demand.
  - Other sources of energy like such as wind and biomass are also considered.
- Waste and water management strategies are formulated such that the building takes care of its own waste through either recycling or reuse methods.

The overall process takes approximately the same time as a conventional building as long as the architect, consultants, and client are enthusiastic and cooperative. Together, all these stakeholders are capable of designing buildings that can completely revolutionize the world today. So, the combined effort of TERI and the MNRE has set forth a novel rating system for green buildings across the country. Now it depends on the people to make their building truly sustainable.

GREEN RATING FOR INTEGRATED HABITAT ASSESSMENT

PRIYANKA KOCHHAR, Research Associate, TERI, New Delhi

The demographic trends of India indicate a consistent rise in urbanization. It is estimated that by 2030, over 33% of the total Indian population would be living in urban areas. The rising population and rapid urbanization would push the demand for housing and commercial spaces, providing a further impetus to the growth of the construction sector in the country.

With a near consistent 8% rise in annual energy consumption of the residential and commercial sectors, the building energy consumption in India has seen a significant growth from a low of 14% in the 1970s to nearly 33% in 2004/05. As per TERI (The Energy and Resources Institute) estimates, there is an annual increased demand of about 5.4 billion units (kWh) of electricity for meeting end-use energy requirement for residential and commercial buildings. This is in addition to the energy requirements for manufacturing of building materials/equipment and energy used during construction (comprising the embodied energy of materials and machinery).

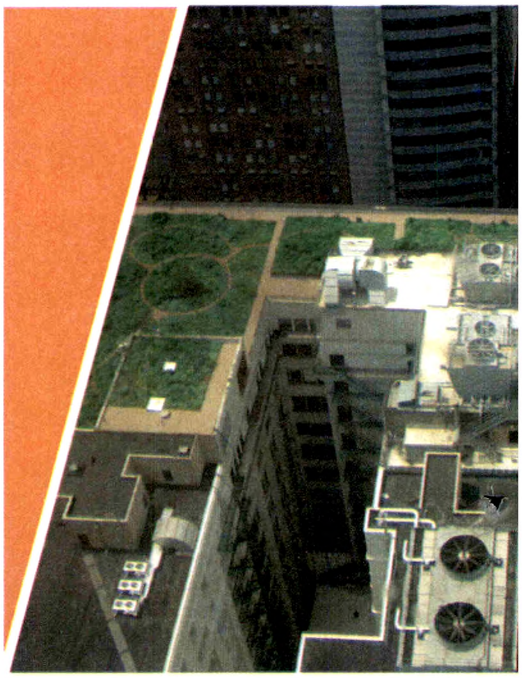
The energy consumption in buildings gives rise, directly and indirectly, to as much as 40% of CO_2 (carbon dioxide) emissions and represents more than a third of global consumption. The demand for energy to run appliances, such as televisions, air conditioners, and refrigerators, is also increasing substantially with rise in living standards. Climate change will further increase site energy demand as people shall seek to maintain comfort levels in more extreme conditions. This puts additional pressure on the emissions balance, which needs to be countered by achieving improvements in energy efficiency.

In a study conducted by TERI, implementation of energy efficiency measures would contribute to a 30% energy savings in new residential buildings and 40% savings in new commercial buildings. In case of existing buildings, the energy saving potential for residential buildings is estimated to be about 20% and that for commercial buildings to be about 30%.

In order to address energy saving within the building sector in India, the National Mission on Sustainable Habitat (which promotes the ECBC [Energy Conservation Building Code], use of energy-efficient appliances, creation of mechanisms that would help finance DSM [demand side management], and solid waste management) and the National Solar Mission provide a wide policy framework that integrate strategies to achieve key national goals from the climate change perspective.

Given the above scenario, GRIHA (Green Rating for Integrated Habitat Assessment) – a tool to facilitate design, construction, and operation of a green building – provides an effective means to implement the national priorities for sustainable habitat.

GRIHA is the national green building rating system for India, endorsed by the MNRE (Ministry of New and Renewable Energy), Government of India. Developed and administered by TERI, the rating system acts as an integrating platform for all relevant Indian codes, standards, strategies, and policy instruments for buildings directed towards our national priorities. It consolidates and builds upon the NBC (National Building Code)



2005, the ECBC 2007, the environmental clearance norms and standards mandated for large construction projects by the MoEF (Ministry of Environment and Forest), the energy labelling programmes for appliances by the BEE (Bureau of Energy Efficiency), several programmes of the MNRE focussed on utilization of renewable energy sources in buildings, the priorities set forth by the MoUD (Ministry of Urban Development) on implementation of infrastructure projects in 63 cities under the JNNURM (Jawarharlal Nehru National Urban Renewal Mission), and the NAPCC (National Action Plan on Climate Change).

GRIHA as an integrating platform for all relevant Indian codes and standards

Let us find out some more about the above-mentioned policy tools.

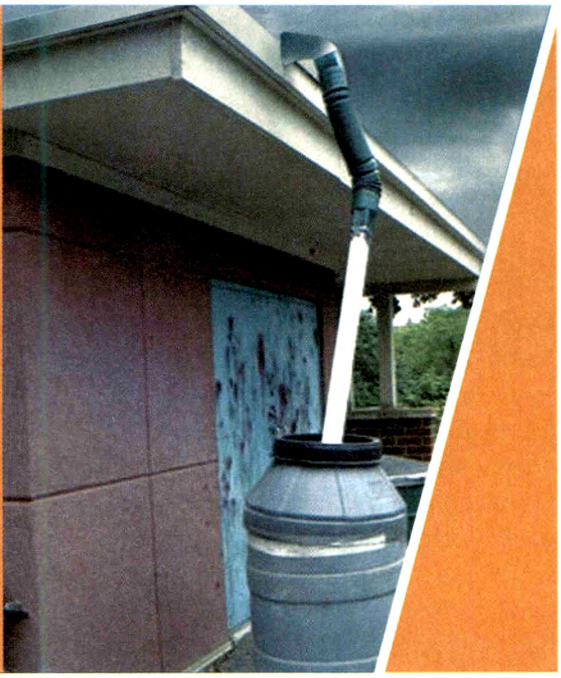
A. Energy Conservation Building Code 2007

The Energy Conservation Act 2001 provides for the establishment of state energy conservation agencies to plan and execute programmes. The Act led to the formation of BEE that started the formulation of the ECBC.

The ECBC covers minimum requirements for building envelope, mechanical systems and equipment, including HVAC (heating, ventilation, and air conditioning) system, interior and exterior lighting system, service hot water, electrical power, and motors in order to achieve energy efficiency in different climate zones of India. For the purpose of the ECBC, the definition of a building is as mentioned in the Energy Conservation Act 2001—'any structure with a connected load of 500kW or contract demand of 600kVA and intended to be used for commercial purposes' (other DSM programmes target residential buildings with lower connected loads). The objective of the ECBC is to reduce the baseline energy consumption by supporting adoption and implementation of efficiency measures in buildings.

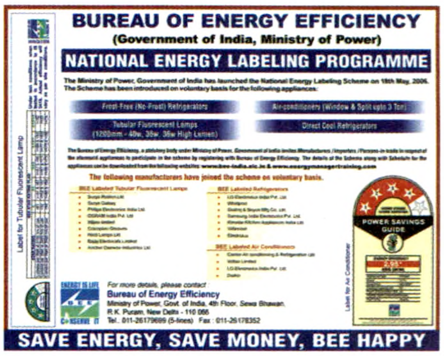
B. National Building Code 2005

The Bureau of Indian Standards has developed the NBC as a guiding code to be followed by municipalities and development authorities in formulation and adoption of building bye-laws. In the latest edition (2005) of the NBC, some aspects of energy conservation and sustainable development have been consistently dealt with in various parts and sections through appropriate design, usage, and practices with regard to building materials, construction technologies, and building and plumbing services.



C. Energy labelling of appliances

The BEE has several programmes to set labels and energy efficiency standards for refrigerators, air conditioners, motors, and other appliances. Energy labelling on voluntary basis for refrigerators and tubular fluorescent lighting was launched in 2006, and since then, labelled products have been in the market.



BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)
NATIONAL ENERGY LABELING PROGRAMME

The Ministry of Power, Government of India has launched the National Energy Labeling Scheme on 18th May, 2006. The Scheme has been introduced on voluntary basis for the following appliances:

- Frost-Free (No-Frost) Refrigerators
- Air-conditioners (Window & Split upto 3 Ton)
- Tubular Fluorescent Lamps (1200mm - 40w, 36w, 36w High Lumen)
- Direct Cool Refrigerators

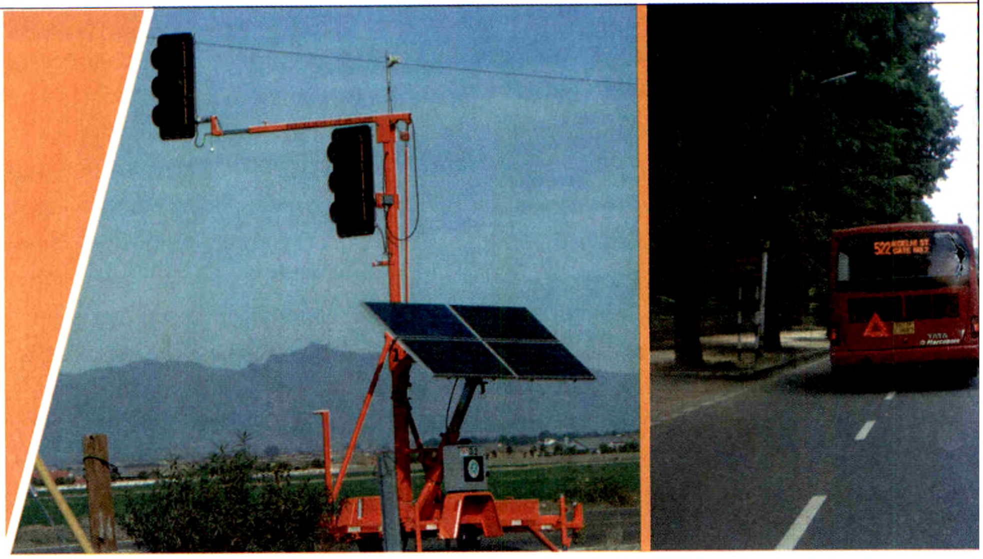
The following manufacturers have joined the scheme on voluntary basis.

For more details, please contact:
Bureau of Energy Efficiency
Ministry of Power, Govt. of India, 4th Floor, Sewa Bhawan,
R.K. Puram, New Delhi - 110 066
Tel.: 011-26179699 (5-lines) Fax: 011-26178352

SAVE ENERGY, SAVE MONEY, BEE HAPPY

D. The Ministry of Environment and Forests

MoEF has established mandatory norms and standards for environmental clearance of large construction projects. All new construction projects are appraised on the basis of the norms and standards by both the EACs (Expert Appraisal Committees) at MoEF and SEACs (State Expert Appraisal Committees) at the state/ union territory level. The EACs/SEACs grade the projects as Platinum (90–100 points), Gold (80–89 points), Silver



(60–79 points), and Bronze (40–59 points) depending on the points achieved. The detailed criteria for grading and the expected performance standard are provided in the manual. The State Pollutions Control Boards verify the compliance of the Environmental Management Plan and the observance of the criteria of grading by the project proponents.

E. The Ministry of New and Renewable Energy

The MNRE has initiated several programmes focusing on the utilization of renewable energy sources in buildings. The MNRE has a solar buildings programme that provides financial support for the design and construction of energy-efficient and solar passive buildings. The MNRE has launched and incentivized GRIHA as a national rating system.

F. National Action Plan on Climate Change

As a response to combat the impacts of climate change, the Prime Minister's Council on Climate Change released India's NAPCC on 30 June 2008. The NAPCC, along with its eight missions, serves as the first country-wide framework on climate change with the approval and support of the Government of India. These eight NAPCC missions map out long-term and integrated strategies to achieve key national goals from the climate change perspective. The NAPCC identifies measures that promote development objective of the country, while producing co-benefits that address climate change effectively.

The National Mission on Sustainable Habitat comprises of three components:

- Promoting energy efficiency in the residential and commercial sector
- Management of municipal solid wastes
- Promotion of urban public transport

In an attempt to promote energy efficiency in the residential and commercial sectors, the mission emphasizes the extension of the ECBC, use of energy-efficient appliances, and creation of mechanisms that would help finance DSM.

In essence, the NAPCC gives a further boost to existing initiatives on green and energy-efficient buildings and constructions in India. IIT (Indian Institute of Technology) Kanpur is an example of a five star GRIHA-rated building where the objectives set by the NAPCC are complied and implemented to achieve substantial energy savings towards sustainable infrastructure development.

Financial incentives for GRIHA-compliant buildings

Recognizing the contribution of GRIHA to the integration of renewable energy into buildings and the improvements in energy efficiency, the MNRE has decided to waive the GRIHA registration fee for government buildings, providing an impetus to the adoption of this national building rating system. The MNRE has incentivized GRIHA and provided financial support in the form of project registration fee waiver, cash award for architects/design consultants, and capital subsidy for installation of SPV (solar photovoltaic) in the building. The MNRE has also announced incentives for architects and Urban Local Bodies to promote GRIHA rating, and overcome some of the split-incentive barriers to energy efficiency in buildings. The details are as follows.

Registration Fee

- 90% of the fee to be reimbursed by the MNRE
- Projects up to 5000 sq m of built-up area with minimum 3 star rating
- Projects >5000 sq m of built-up area with minimum 4 star rating
- Release of funds to owners after validation of star rating post-construction

Incentive to architects/design consultants

- Projects up to 5000 sq m of built-up area with minimum 3 star rating—Rs 2.5 lakh
- Projects >5000 sq m of built-up area with minimum 4 star rating—Rs 5 lakh
- Release of incentives to architects/design consultants after validation of star rating post-construction

Capital subsidy for SPV installations

- 1% of total connected load for interior lighting and space conditioning, subject to a maximum of 100 KW, to be provided capital subsidy
- Support at the rate of Rs 75 000 per KW may be provided as capital subsidy
- Release of capital subsidy to the owner after validation of the final rating post-construction
- Choice of system configuration – stand-alone, with or without battery storage, or grid connected, or BiPV – to be left to the owner

Urban Local Bodies

- One-time incentive of Rs 50 lakh to municipal corporations and Rs 25 lakh to other ULBs will be available, which announce rebate on property tax for energy-efficient solar/green buildings rated under GRIHA and make it compulsory to get the new buildings under government and public sector rated under GRIHA.
- An MOU will be signed by the concerned municipal corporation/ ULB with GRIHA Secretariat for large-scale promotion of green buildings in their area.
- Awards of Rs 50 lakh to municipal corporation and Rs 25 lakh to other ULB that performs the best

Details of GRIHA criteria

The convergence of national priorities is crucial to the implementation and mainstreaming of sustainable habitats, where GRIHA plays an important role through assessment and rating of buildings. It is a five star rating system for green buildings (five stars being the highest rating, refer Figure 1), which stresses on passive solar techniques for optimising indoor visual and thermal comfort. Developed for commercial and residential buildings, the rating system sets benchmarks for air-conditioned and non-air-conditioned buildings in five climatic zones, namely hot-dry, warm-humid, composite, temperate, and cold.

51–60 points	★ ★
61–70 points	★ ★
71–80 points	★ ★ ★
81–90 points	★ ★ ★ ★
91–100 points	★ ★ ★ ★ ★

Figure 1 GRIHA Star Rating

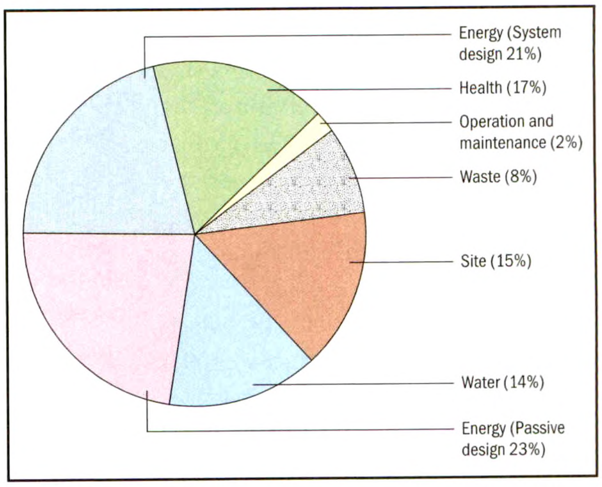


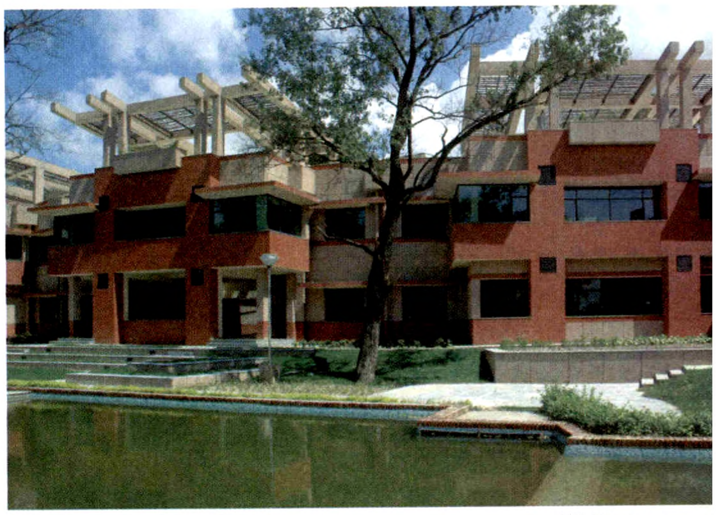
Figure 2 Weightage allocated to various GRIHA criteria

In order to address energy efficiency, GRIHA encourages optimization of building design to reduce conventional energy demand and further optimize energy performance of the building within the specified comfort limits. A building is assessed on its predicted performance over the entire life cycle from inception through operation.

GRIHA comprises of a set of 34 criteria that address sustainable site planning, optimized energy performance, use of efficient materials and construction practices, integration of water and waste management strategies, indoor environmental quality, and health, comfort, and safety of human beings. It is a 100+4 point system where differential weightage is allocated on various criteria (refer Figure 2).

Case studies

The CESE (Centre for Environmental Sciences and Engineering) building at IIT Kanpur highlights that GRIHA acts as an integrating platform for all relevant codes/tools and policies of the government towards achieving energy efficiency, and also promotes energy efficiency. The building is the first 5-star GRIHA-rated building.



IIT Kanpur

Building overview

The CESE building is a research facility located in the IIT campus in Kanpur. The facility houses laboratories and other facilities for various disciplines of the environment sciences, like Atmospheric, Oceanographic, Earth Sciences, and so on.

The building has wet labs, which are non-air-conditioned spaces on the ground floor, and dry labs, which are air-conditioned spaces on the first floor. The building design and envelope have been optimized by selecting appropriate wall and roof construction and thorough adoption of solar passive measures. This was done after studying the sun path analysis to provide shading devices for windows and roof, which would reduce energy demand to condition the spaces.

All the commitments, as described in GRIHA to optimize the system design and to achieve thermal comfort in non-air-conditioned spaces, have been followed to reduce the annual energy consumption less than the benchmark established for composite climate by GRIHA. Water conservation measures are adopted in the building through selection of efficient fixtures and rainwater harvesting. Utilization of renewable sources of energy, by building integrated photovoltaic panels, has been incorporated for use in the building. Rainwater harvesting is done and treated wastewater is reused for irrigation. The building is also fully compliant with the ECBC.

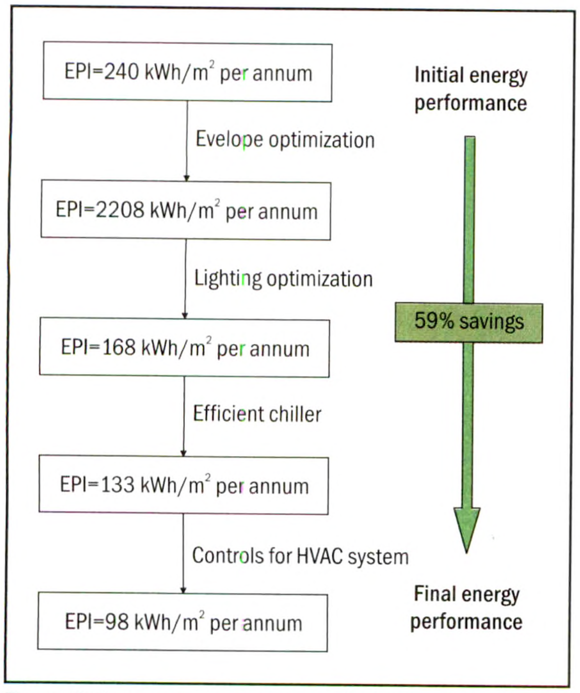

EPI=240 kWh/m^2 per annum
Evelope optimization
EPI=2208 kWh/m^2 per annum
Lighting optimization
EPI=168 kWh/m^2 per annum
Efficient chiller
EPI=133 kWh/m^2 per annum
Controls for HVAC system
EPI=98 kWh/m^2 per annum
Initial energy performance
59% savings
Final energy performance

Figure 3 Energy savings achieved by the various design interventions in the CESE building

Design of an earth air tunnel, which uses the geothermal property of the earth, has resulted in a reduction of more than 15% of the building cooling load. Efficient condenser cooling through an on-site water body and use of thermal energy storage has increased the efficiency and reliability of the air-conditioning system.

Figure 3 provides an indication of the energy savings achieved by the various design interventions in the CESE building to be GRIHA-compliant.

The GRIHA rating procedure

The buildings seeking GRIHA certification may register with the GRIHA Secretariat at www.teriin.org/griha/. The project facilitator (client) shall act as the link between the GRIHA Secretariat and the various project consultants, and be responsible for collating all relevant documents and submittals for the project. The GRIHA Secretariat shall conduct a one-day programme for the facilitator and all concerned consultants of the project before submitting a report on GRIHA Compliance of the project.

Once all the criteria committed in the compliance report are integrated in the building design, documentation on the same shall be submitted to the project facilitator. After initial vetting by the GRIHA Secretariat, the same would then be submitted to the evaluator panel, which shall comment and recommend the rating for the project to the TAC (Technical Advisory Committee). The TAC shall further nominate the project to the NAC (National Advisory Committee) before a provisional certificate is issued. The MNRE shall award the final rating after the post-occupancy audit is conducted.

In short, the procedure is as below:

- GRIHA Registration (on www.teriin.org/griha/)
- Sharing of all documents and submittals with GRIHA Facilitator
- One-day workshop to assess GRIHA compliance
- Report on GRIHA compliance
- Vetting of documentation submitted by Facilitator
- Submission of project documentation to evaluator panel
- Incorporation of evaluators' comments, if any (to achieve a maximum star rating)
- Recommendation of Star Rating to TAC
- Provisional certification
- Post-occupancy audit
- Award of GRIHA rating by the MNRE

Conclusion

Since its announcement in 2007, a GRIHA rating has been facilitated for over 28 building projects. Several programmes on generating awareness on the subject of green buildings and capacity building have been taken up. So far, GRIHA compliance of new buildings has shown significant impact in terms on CO_2 emission reduction. As a result, the CPWD (Central Public Works Department), as per its office memorandum, has notified that all their construction shall henceforth be green and follow the GRIHA rating system.

Ongoing projects

1. Akshay Urja Bhawan of HAREDA

HAREDA should lead by example and so this building will be a 'model of sustainability'. It should be emphasized that the attempt has been to make the building as 'green' as possible.

The primary concern while designing the building was to be able to achieve comfortable conditions inside the building throughout the year with the least amount of conventional energy being used. Also, the idea is to reduce the harmful impact of the building on the environment and the inhabitants. The characteristics of a 'green' building, which have been considered while designing this building are:

- Reduced energy consumption without sacrificing the comfort levels
- Reduced destruction of natural areas, habitats, and biodiversity, and reduced soil loss from erosion, and the likes.
- Reduced air and water pollution (with direct health benefits)
- Reduced water consumption
- Limited waste generation due to recycling and reuse
- Reduced pollution loads and increased user productivity
- Enhanced image and marketability
- Maximum daylight use
- Simplicity
- Minimum CO_2 emissions
- Integration of structure and service routes to optimize usable space and hence, minimize materials

The efficiency of the building is mainly due to the concept of cooling, ventilation system, water recycling, water-efficient fixtures, building shades, daylight harvesting, and landscaping system that were proposed at the stage of design. Finally, the design satisfies the energy efficiency requirements expected out of the facility.

2. Fortis Hospital, Shalimar Bagh, New Delhi

The Fortis Hospital at Shalimar Bagh, New Delhi, is being designed with a vision to be an environment-friendly health care facility. The hospital has been planned as a 500-bed facility, which would cover a built-up area of 64400 sq m. The hospital is being designed as an energy-efficient building that complies with the ECBC and is undergoing TERI-GRIHA rating certification. It is the first hospital building in India to have registered for the green building rating system.

Sustainable design concepts are incorporated in different aspects of the building design, starting from sustainable site planning. Simulation and analysis of various alternatives led to the optimization of building envelope to reduce external solar gains. In-depth analysis and optimization of the lighting system has resulted in significant savings in lighting system in the building. Simulation of the air-conditioning system has enabled evaluation and selection of various energy efficiency measures. Additionally, renewable energy, eco-friendly materials, and waste and water management techniques will be adopted in the hospital building. As a commitment to control ozone-depleting substances in the atmosphere, the hospital would install CFC (chlorofluorocarbons)- and HCFC (hydro chlorofluorocarbons)-free equipment for the refrigeration and air-conditioning systems.

3. ITC Chennai Hotel Project

The design concept of the hotel is based on the art and architecture of the Chola Dynasty, which existed between AD 850 and AD 1280 in Tamil Nadu, in and around the present-day Tanjore. The Chola period is regarded as the 'Classic Age' of art and architecture for southern India.

The hotel will reflect the beauty of Chola architecture and design, both in the interiors and the exteriors. The design has elements taken from Chola art, architecture, and history. The combining of the need to reflect the Chola history and architecture along with the requirements of a modern-day building, which respects the 'triple bottom line' philosophy (social, economic, and environment) of ITC,

Chola architecture

Metro Station, Sushant Lok, Gurgaon

has been seamlessly done. Energy efficiency has been kept in mind, while working on the building envelope. In the interiors, utilization of daylight to suit the ambience and optimization of lighting power densities have been stressed. Building peak AC load has been arrived at by appropriate modelling exercise. Engineering infrastructure for hotel operations is selected after a thorough evaluation of energy efficiency of the equipments. The variable requirements under operating conditions have also been taken into account. Environment has been consciously kept in mind right from the day the work started at the site. The first activity was landscaping, which sought to green the site.

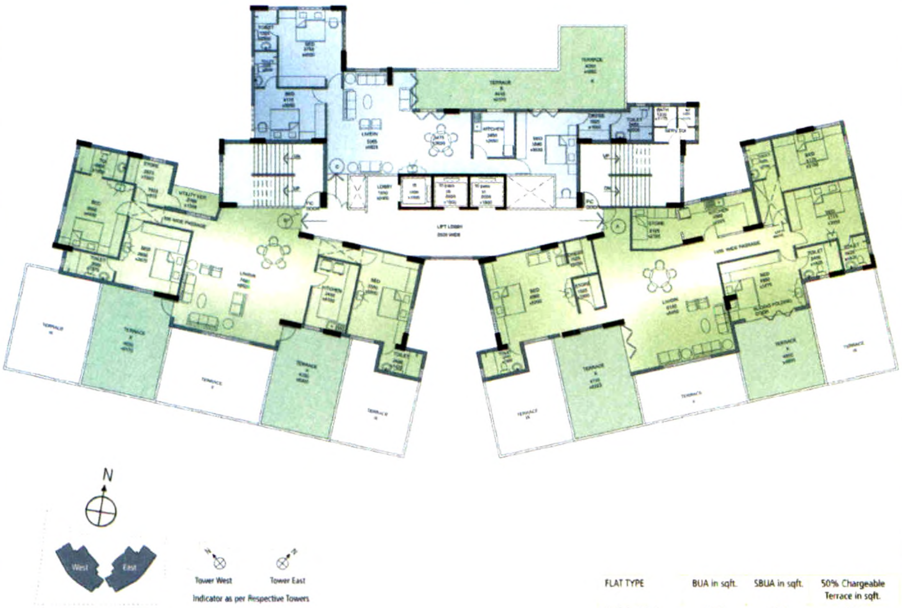
4. Merlin Projects Ltd

Merlin Tropical Greens is a 'master planned community' developed on 46 acre of land with approximately 5 acre of water bodies. The planning has been done in such a way that the water bodies are preserved and protected with another layer of green buffer. There are approximately 200 plots where villas of different categories will be built to suit the tropical climate and provide contextual architectural styles deriving from the local vernacular of the tropics. Verandahs, courtyards, and screens provide passive cooling as well. The site plan manages storm water efficiently with the run-off collecting in the water bodies. The street system also follows planning measures to slow traffic movement. The pathways connecting the water bodies would provide contiguous walks. The landscape planning can also supplement the environment. This project attempts to comprehensively deal with land planning for second or weekend homes, spas, and so on to connect to the context and develop sustainable land planning. Approximately 27 acre of the land is saleable. The difference caters to green and grey infrastructure.

5. Metro Station, Sushant Lok,Gurgaon

This is a commercial development project comprising of commercial space and metro rail station proposed in Sushant Lok at Gurgaon. This complex contains various functional spaces at different levels of the building, including retail, station houses, offices, ticketing counters, public areas, and security and police office. The third floor has platforms, offices, equipment rooms, and the likes. The road-level has certain area earmarked for parking and landscaping.

The attempt is to design the building in a manner so as to provide adequate thermal and visual comfort by exploiting nature's resources (like sunlight and wind-flow orientation) to the optimum possible extent.



10th Floor Plan

FLAT TYPE	BUA in sqft.	SBUA in sqft.	50% Chargeable Terrace in sqft.
A-4B/R+4 Bath	2030	2706	263
B-3B/R+3 Bath	1690	2253	298
C-3B/R+3 Bath	1350	1800	216

ENERGY-EFFICIENT SOLAR/ GREEN BUILDINGS SCHEME

DR ASHVINI KUMAR, Director, MNRE

Energy-efficient solar buildings are constructed based on the techniques of solar passive design with a view to provide comfortable living and working conditions, both in winter and in summer. These buildings can be integrated with renewable energy and energy conservation devices and systems, and can save over 30% to 40% of conventional energy that is used for lighting, cooling, or heating. Such buildings have been tried out in a few states in India. The state governments of Himachal Pradesh, Punjab, Haryana, and Nagaland have already made it mandatory to construct all new buildings in government and public sectors on this concept. The development authorities have been asked to approve building plans for construction only if the designs incorporating solar passive features are certified by approved architects or experts. Over 40 experts/ architects in the country are presently involved in practicing energy-efficient solar buildings. BEE (Bureau of Energy Efficiency) has recently introduced ECBC (Energy Conservation Building Code), which includes energy-efficient design features. National building codes have also been developed by the BIS (Bureau of Indian Standards), which incorporates some of the concepts of energy-efficient solar buildings. Sufficient literature/publications is also available for designing such buildings.

Building rating systems have been quite effective in raising awareness and popularizing energy-efficient and green building designs. Most of the internationally devised rating systems have been tailored to suit the building sector in India. For instance, a US-based LEED (Leadership in Energy and Environmental Design) Rating System is under promotion by CII-Godrej GBC (Green Business Centre), which focuses on energy efficiency measures in AC (air-conditioned) buildings. A couple of other rating systems suitable for Indian conditions, such as TERI-GRIHA (The Energy and Resources Institute–Green Rating for Integrated Habitat Assessment) and Eco-housing Systems have also been developed.

Keeping in view our climatic conditions, and in particular, the construction of non-AC buildings, a national rating system called GRIHA has been developed, which is suitable for all types of buildings in different climatic zones of the country. The rating system was initially conceived and developed by TERI. It has been modified as a national rating system. It takes into account the provisions of the National Building Code 2005, the ECBC 2007, and other IS codes and local bye-laws. Through various qualitative and quantitative assessment criteria, GRIHA 'rates' buildings on the degree of their 'greenness'.

A memorandum of understanding has been signed by the MNRE (Ministry of New and Renewable Energy) and TERI towards the development and operationalization of the National Rating System GRIHA for green buildings. A NAC (National Advisory Council) has been constituted to provide advice and directions to the National Rating System.

A TAC (Technical Advisory Committee) has also been constituted to provide technical supervision to modifications and constant upgradation of the GRIHA framework. GRIHA will be operated through GRIHA secretariat, which will be hosted by TERI.

Financial Provisions

GRIHA Secretariat

GRIHA Secretariat will act as an independent autonomous body. It will be registered by TERI under Society's Act. A seed funding of up to Rs 10 million will be made available to the Society for its establishment and infrastructure facility as non-recurring grant based on the proposal received from TERI with details of the budget required. However, till the Society is formed by TERI, the Secretariat will function from the office of TERI at Delhi.

Buildings rated under National Rating System—GRIHA

The scheme is presently confined to commercial and institutional buildings, including housing complexes with minimum built area of around 2500 sq m. All the houses in a complex will be considered as a single project and individual houses will not be covered.

A. Registration-cum-rating fee

Ninety per cent of the fee as given below for projects rated 3 star with built area of up to 5000 sq m and for projects rated 4 star with built area above 5000 sq m will be reimbursed by the MNRE.

Owners of buildings under design and construction, interested to be rated under GRIHA will get their buildings registered with GRIHA Secretariat as per the procedure given at GRIHA and the MNRE website. Registration-cum-rating fee for the projects registered under GRIHA will be as per below, which will be paid to GRIHA Secretariat by the owners during registration. The release of registration fee will be made by the MNRE on reimbursement basis through GRIHA Secretariat after validation of Star Rating post construction by the NAC.

The first 100 government/public sector buildings shall be exempted from paying registration-cum-rating fee in advance at the time of registration under GRIHA, and 100% fee will be released in respect of such cases to the GRIHA Secretariat under TERI in the following manner.

- 50% after the projects are registered with GRIHA Secretariat and documents sent to the MNRE. The institutions will give undertaking that they will put their best efforts in getting their buildings rated 3 or 4 stars as per the scheme/guidelines. They will also commit to achieve all mandatory points under GRIHA.
- Rest 50% after they get a provisional rating of 3 or 4 stars as per The scheme guidelines.

The cases of exemption will be considered on first-come-first-served basis. The relaxation in any of the above conditions shall be considered and granted by the competent authority on merits in line with the scheme.

B. Incentive to architects/design consultants

To encourage architects and consultants to design green buildings and get them rated under GRIHA, incentive as per below will be available from the MNRE.

- Rs 2.50 lakh for projects up to 5000 sq m built-up area with minimum 3 star rating
- Rs 5 lakh for projects >5000 sq m built-up area with minimum 4 stars

Procedure for release of the incentives to architects/design consultants and settlement of account with the MNRE will remain same as given above.

C. Capital subsidy for SPV installations

One of the criteria under GRIHA is to meet 1% of the total connected load for interior lighting and space conditioning through solar photovoltaics. It has been decided that such photovoltaic systems would be supported through capital subsidy, which will be made available under the MNRE's scheme on Solar Photovoltaic Systems/Devices for Urban Areas.

Project size (total built up area)	Rating cum registration fee
<= 5000 sqm	Rs 314 000 (Rs 250 000 fixed cost for registration and Secretariat fees + Rs 64 000 for evaluation)
>5000 sq m	Rs 314 000 (fixed cost for projects up to 5000 sq m) + Rs 3.75/sq m over and above 5000 sq m of built area

Other items

Promotional activities: A financial support of up to Rs 2 lakh for each activity could be provided to implementing agencies for organizing workshops/seminars/training programmes, meetings of NAC, publications/awareness campaigns, and so on.

Submission of proposals and release of funds: The proposals on promotional activities could be generated by SNAs (state nodal agencies)/municipal corporations/government bodies/reputed NGOs/GRIHA Secretariat, and so on, and submitted to the MNRE in the prescribed format (See Appendix 1). Eighty per cent of the CFA sanctioned will be released in advance on merit and rest on progressive achievements/completion of the activities with detailed reports and utilization certificates/SOE received by the MNRE. To private bodies, the funds will be released on reimbursement based or on the basis of the bond submitted to the Ministry.

Incentives to Urban Local Bodies: A one-time incentive of Rs 50 lakh to municipal corporations and Rs 25 lakh to other Urban Local Bodies will be available to those who i) announce rebate on property tax for energy-efficient solar/green buildings rated under GRIHA ii) make it compulsory to get the new buildings under government and public sector rated under GRIHA, and iii) sign an MOU with GRIHA Secretariat in presence of the MNRE for large-scale promotion of green buildings in their area.

Submission of proposals and release of funds: To avail the incentive, municipal corporations/municipalities/Urban Local Bodies will submit an application to the Ministry, with a copy marked to SNA, giving details of notifications/orders announcing rebate on property tax for energy-efficient solar buildings and mandatory provisions of new government/public sector buildings rated under GRIHA. Release will be made directly to them in two parts, one after receiving the application complete in all respect and the other after receiving the progress report of green buildings after a period of one year.

Institution of awards/incentive: Annual awards to green buildings, which are rated as 5 stars under GRIHA and platinum rated under other rating systems, will be given in the form of shields/certificates. Cash incentive of Rs 50 lakh will be provided to municipal corporations and Rs 25 lakh to municipalities/other Urban Local Bodies (one each to them) who perform the best in promoting construction of green buildings in their respective areas from 2011/12 onwards.

Other activities: Funds will be provided for other activities to promote green buildings in the country. These activities may include development of web-based tools, short films on best practices, FAQs on the MNRE website, course contents as part of curriculum, e-learning modules, organizing specific groups to initiate changes in National Building Code, support to architectural magazines to bring out special features on green buildings, and so on.

Implementation Arrangement

The scheme will be implemented through SNA/municipal corporations/government bodies/reputed NGOs, and so on. The above-mentioned guidelines for implementation of the scheme and financial provisions for various activities will be followed. The scheme will be reviewed after two years or before as felt necessary.

APPENDIX 1

Format for submission of proposals for organizing seminars/ symposia/ workshops/training programmes, and so on

1. Name of institution organizing the event:
2. Type of event to be organized:
3. Date(s)/venue of the event:
4. Category of participants:
5. Tentative programme with topics to be covered (copy to be enclosed):
6. Budget break-up (item-wise):
7. Expected outcome:

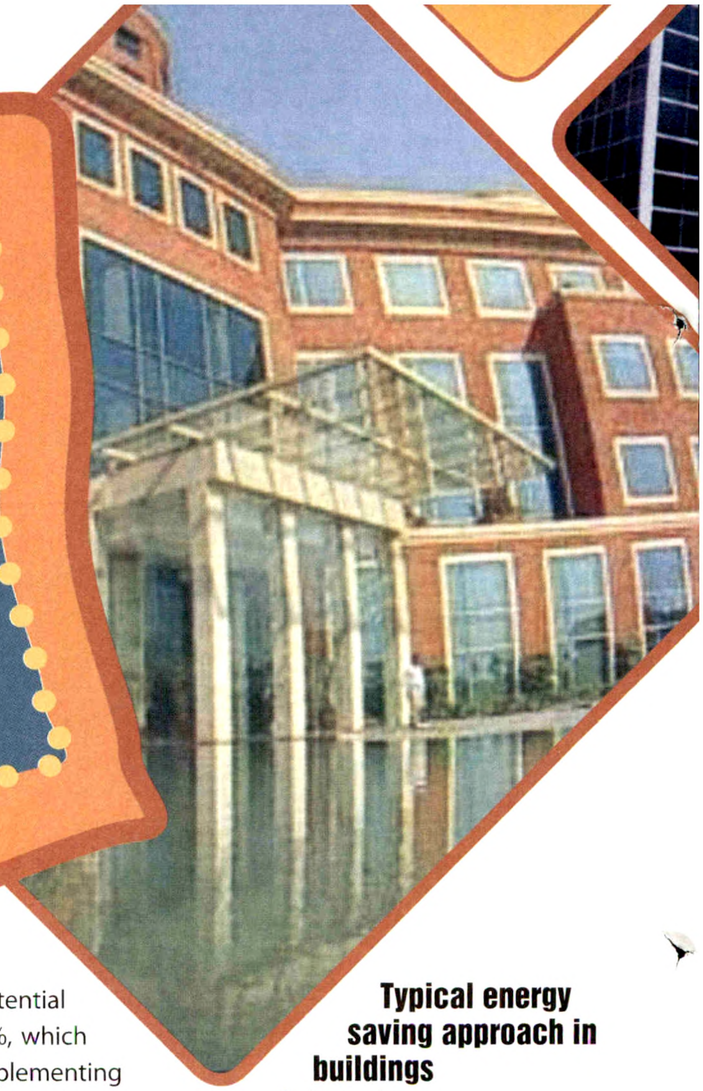
Signature with name and seal of Head of implementing organization

Format for submission of proposals for organizing publicity and awareness campaign/publication of documents

1. Name of institution organizing the activity:
2. Type of activity to be organized:
3. Details of activities to be organized:
4. Budget break-up (item-wise; supporting documents for arriving at the figures to be provided):
5. Expected outcome:

Signature with name and seal of Head of implementing organization

Energy Efficiency in Green Building in Design and Construction



The construction industry in the country is growing at a rapid pace at about 8% per annum, as compared to the world average of 5%. Hence, energy efficiency in the building sector assumes tremendous importance. In developing countries like India, population growth rate is expected to grow at 1.3%, while the energy consumption rate is expected to grow at 4.3%. This trend would strain the energy sector to a large extent.

Commercial buildings are the third largest consumers of energy, after industry and agriculture. Buildings annually consume more than 20% of electricity used in India. The potential for energy savings is 40%–50% in buildings, if energy efficiency measures are incorporated at the design stage. For existing buildings, the potential can be as high as 20%–25%, which can be achieved by implementing house-keeping and retrofitting measures. The incremental cost incurred for achieving energy efficiency is 5%–8% vis-à-vis conventional design cost, and can have an attractive payback period of 2–4 years.

Typical energy consumption pattern in buildings

In a typical building, air conditioning is the highest consumer of energy, followed by lighting and other miscellaneous equipment. Therefore, if the initial design considers energy efficiency measures in these areas, substantial energy savings can be realized.

Typical energy saving approach in buildings

Orientation

This is the first step to achieve energy efficiency. The following measures can be adopted.

- Minimize exposure on the south and west
- Use simulation tools and techniques that can help in designing the building orientation to minimize

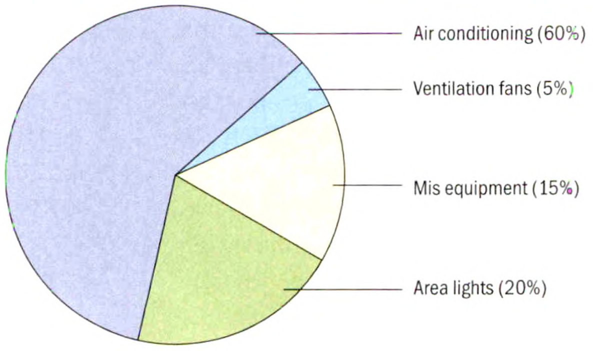
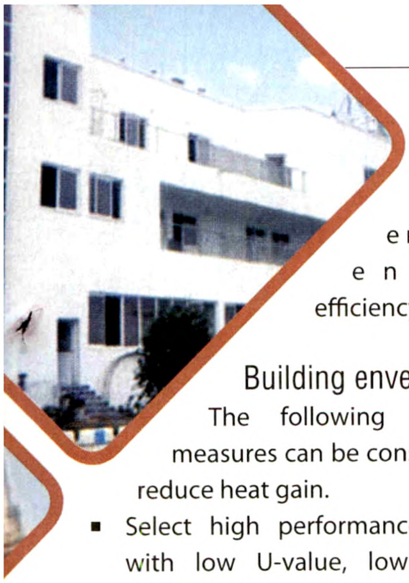


Figure 1 Break-up of energy consumption in a building



heat ingress and enhance energy efficiency.

Building envelope

The following envelope measures can be considered to reduce heat gain.

- Select high performance glazing with low U-value, low Shading Coefficient, and high VLT (Visual Light Transmittance).
- Insulate the wall. The options for insulation materials can be extruded polystyrene, expanded polystyrene (thermocol), Polyurethane, Glass wool, and the likes.
- Brick wall with air cavity can also significantly reduce the heat ingress.
- Hollow blocks, fly ash bricks, and AAC (Autoclaved Aerated Concrete) Blocks are also good insulators.
- The heat ingress through the roof can be as high as 12%–15%. Heat reflective paints and garden roofs result in substantial heat reduction.
- Consider shading devices for window openings and skylights.

Equipment and systems

- Select chillers with high CoP (Coefficient of Performance).
- Install VFD (Variable Frequency Drives) for supply, and return air fans and pumps.
- Select high efficiency cooling towers.
- Use high efficiency motors, transformers, and pumps.
- Install heat recovery wheels and economizers.
- Consider night purging with ambient air to flush out the heat trapped within the building during the day.
- Adopt controls and BMS (Building Management System) for effective control.
- Use BEE (Bureau of Energy Efficiency)/energy star-rated appliances.
- Engage a Commissioning Authority to ensure that savings are realized once the building becomes operational.

Lighting

- Design in such a way that the building gets maximum day lighting.
- Overall lighting power density can be designed as less as 0.7 W/sq ft.
- Use daylight-cum-dimmer controls.
- Install occupancy sensors.
- Select energy-efficient luminaries like LED, CFL, T-5, and so on.

IGBC rating systems and energy efficiency

The green building rating systems developed by the IGBC (Indian Green Building Council) are voluntary, consensus-based, and market-driven building programmes and are designed to address national priorities. These rating systems are adaptive to five climatic zones of India. The LEED (Leadership in Energy and Environment Design) rating system has been indigenized by the IGBC to suit the national context and priorities. The launch of 'LEED India New Construction', 'LEED India Core and Shell', 'IGBC Green Homes', and 'IGBC Green Factory Building' rating systems is an important step in this direction.

Energy efficiency in design has been achieved by a number of buildings in India by adopting the IGBC green building rating system. An IGBC-rated building consumes 30%–50% lesser energy, as compared to a conventional building. These buildings are designed to meet and surpass the ECBC (Energy Conservation Building Code) standards. Energy performance of three 'LEED Platinum'-rated buildings has been monitored for about 3 years and energy savings achieved are shown in Table 1.

The IGBC has launched four rating programmes LEED India NC (New Construction), LEED India CS (Core and Shell), IGBC Green Homes, and IGBC Green Factory Buildings. Till date, 407 projects with a built-up area of more than 272 million sq ft have registered for rating. And 39 buildings have achieved the Green Building Certification in India.

Table 1 Monitoring of energy savings in LEED rated buildings

Building	*Built-up area (sq. ft.)*	*Consumption of conventional building (kWh)*	*Consumption of LEED designed building (kWh)*	*% reduction*	*Annual energy savings (Rs in lakhs)*
Wipro Technologies, Gurgaon	1,75,000	48,00,000	31,00,000	40%	102
ITC Green Centre, Gurgaon	1,70,000	35,00,000	20,00,000	45%	90
CII Godrej GBC, Hyderabad	20,000	3,50,000	1,30,000	63%	9

Use of renewable energy in green buildings in india

The use of renewable energy technologies are encouraged and adopted in various IGBC-certified green buildings, both in-situ and off-site. This will facilitate the country to move away from the dependence on fossil fuels and reduce the carbon emissions. The green building technologies that have been incorporated in the building design of various IGBC-certified green buildings are as follows.

1. Building integrated solar photovoltaics
2. Solar air conditioning
3. Wind energy
4. Geothermal
5. Biomass

Challenges and opportunities

Achieving energy efficiency in buildings poses a number of challenges, and at the same time, presents a host of opportunities. A few of them are discussed below.

Awareness and training

Incorporating energy efficiency measures at design stage requires knowledge of the green building concepts. There is now a need for skilled and knowledgeable professionals who have a deep understanding of architecture and energy systems.

The IGBC is addressing this through a number of training and awareness programmes all over the country. So far, 6000 professionals have been trained on these concepts. Energy simulation programmes are excellent tools to design energy-efficient buildings. The tools that are typically used are Visual DOE, Energy Plus, and Lumen Micro. However, the number of trained professionals on these tools and techniques is scarce as of now.

Availability of materials, equipment, and technologies

The availability and affordability of materials/equipment that contribute to energy efficiency is another major challenge. Tremendous potential exists for materials and equipment like BIPV (Building Integrated Photo Voltaics), heat resistive paints, fly ash blocks, insulation materials, high efficiency chillers, lighting controls, and so on. New technologies like solar air conditioning, wind towers, geothermal system, and earth tunnel cooling are gaining importance. The business opportunity for these products and technologies is expected to cross $40 billion by 2010. To facilitate the penetration of these products, IGBC has platforms like Green Building Congress, Permanent Technology Centre in CII-Godrej GBC, and IGBC local chapter meetings to showcase energy-efficient products.

Sustained savings

A building can have the best of materials, equipment, and systems in place at the design stage. However, the building can sustain the savings only if it is monitored on a continuous basis. LEED-rated buildings use IPMVP (International Performance Measurement and Verification Protocol) to monitor and sustain the savings. Proper measurement and verification of savings will help the building owner to fine-tune the base line and achieve high level of savings. Applying rating programmes like LEED EB (LEED for Existing Buildings) can help buildings to sustain energy-efficient practices over the life of the building.

National codes and standards

The Indian government has launched the ECBC, which is voluntary and applicable to buildings or building complexes that have a minimum connected load of 500 kW or a contract demand of 600 kVA, whichever is greater. This code addresses the minimum performance standards for energy efficiency in a building, covering building envelope, HVAC systems, service hot water and pumping, lighting systems, electrical power, and motors. This is an excellent initiative that will enable design of high performance buildings.

Conclusion

Energy efficiency in buildings has assumed paramount importance owing to the tremendous growth in the building sector. The energy saving potential is enormous, if addressed right at the design stage. The application of codes like ECBC as a benchmark can help in designing high performance buildings. And there are tremendous opportunities to introduce new equipment, technologies, and materials, which can help enhance energy efficiency of buildings.

IGP Office Complex, Gulbarga: India's first naturally ventilated Government Green building

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GREEN BUILDING MOVEMENT IN INDIA

CII – Sohrabji Godrej Green Business Centre, Hyderabad
India's first platinum rated green building

India is witnessing tremendous growth in infrastructural development. Construction is one of the largest economic activities in the country. As the sector is growing rapidly, preserving the environment poses as a major challenge. At the same time, it also presents opportunities for various stakeholders. The construction sector, therefore, needs to play a responsible role towards the preservation of the environment. The green building movement in India, pioneered by the IGBC (Indian Green Building Council), is a step in this direction.

Indian green building council

The IGBC, a part of the CII-Godrej GBC (Confederation of Indian Industry Sohrabji Godrej Green Business Centre), was formed in 2001. It is represented by all stakeholders of construction industry, comprising of corporate, government, nodal agencies, architects, designers, institutions, builders and developers, product manufacturers, suppliers, facility managers, and so on. The visions of IGBC are to usher in a green building movement in India and to become one of the world leaders in green buildings by 2010. Today, the council is strong with over 614 formally registered members, including 70 founding members. To facilitate the penetration of green building concepts throughout the country, local chapters have been launched in Ahmedabad, Bengaluru, Chennai, Delhi, Hyderabad, Kolkata, Kochi, Mumbai, and Pune, with a mission to spread the IGBC vision at the regional levels.

Growth of green building projects in india

The green building movement has gained tremendous impetus over the last six years. It began with a modest figure of 20 000 sq ft of 'green' built-up area in the country in 2003. Today,

Dr Farooq Abdullah, Union Minister of MNRE, visited Olympia Tech Park, Chennai, India's largest Green IT Park Building

Table 1 **Quick snapshot on Green Building Movement – The growing numbers**

Criteria	*2001*	*Till Date*
CEOs & senior people involved	50	≈5,000
No. of professionals trained on green buildings rating	10	≈6,000
No. of registered Green Buildings	1	407
Built – in Area (sq.ft)	0	272 Million
Green Building products and equipment	5	80
IGBC Membership	0	614

Hillary Clinton, US secretary of state visited ITC Green Centre, Gurgaon

more than 407 green buildings with a built-up area of over 272 million sq ft are being constructed all over India.

Launch of green building rating systems

To facilitate the adoption of green building practices relevant to the local climate and regional practices for various building types, IGBC has developed new rating programmes. These rating systems are voluntary, consensus-based, and market-driven building programmes, and are designed to address national priorities. An important development in the growth of the green building movement has been the indigenization and launch of LEED (Leadership in Energy and Environment Design)—India's green building rating system for new construction, and core and shell. LEED India rating system has been designed to suit the Indian construction industry. The launch of 'IGBC Green Homes' and 'IGBC Green Factory Building' rating systems is another important step in this direction.

Benefits experienced in green buildings

Green Buildings result in both tangible and intangible benefits.

Tangible benefits Few of the green buildings, which have been in operation for the last 5 years, have been monitored for operational savings.

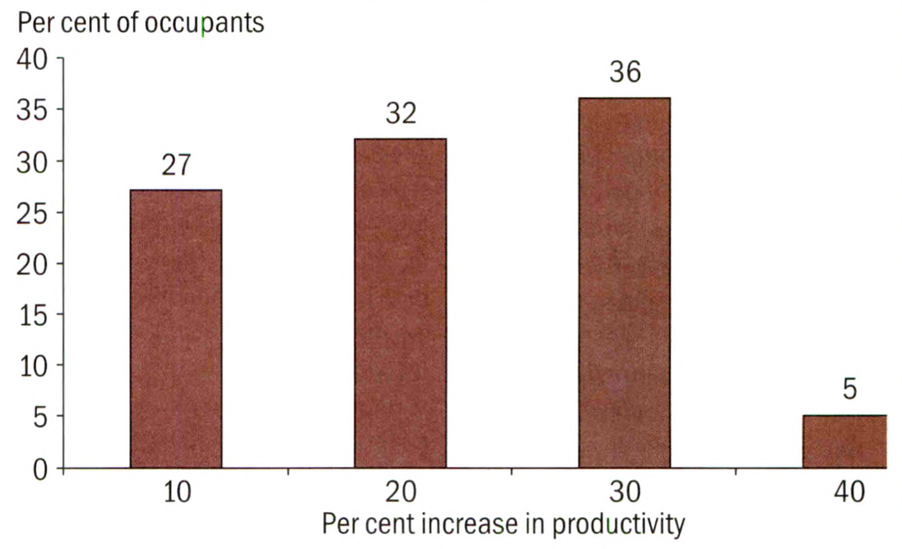

Figure 1 Occupants' perceived productivity gain

Intangible benefits A survey was carried out to identify the perceived intangible benefits at the CII Godrej GBC building in Hyderabad. The survey clearly indicated that more than 90% of the occupants are satisfied with the indoor day lighting levels. And 100% of the occupants perceived productivity gains. Figure 1 provides the results of the survey. The overall productivity, when one calculates the weighted average of the feedback of all the respondents, works out to an overall gain of 21%.

Perceptions and realities on green buildings

People have different perceptions on green buildings; some are correct and some are not. The main ones are as follows.

Perception 1: Green buildings are costlier

Reality

Considerable research and analysis has been carried out on the cost impacts of a green building. The cost could be slightly higher than a conventional building. But then, this needs to be seen with a different paradigm.

The question is how do we compare the costs?

There needs to be a baseline cost for all comparisons to be alike. The incremental cost is always relative and depends on the extent of eco-friendly features already considered during design. The incremental cost would appear small if the baseline design is already at a certain level of good eco-design; it would appear huge if the base design has not considered green principles.

The second and a rather critical paradigm is to look at the incremental cost in relation to the life cycle cost. This kind of an approach could be revealing. Over its life cycle, the operating cost would work out to 80%–85%, while the incremental cost (which is a one-time cost) is only 8%–10%.

Table 2 captures the typical payback period in the recently constructed green buildings in India.

There is a decreasing trend in the incremental cost over the years. This trend would continue and soon, the cost of a green building would be lower than a conventional building.

Perception 2: Green buildings take more time

Reality

There is a general perception that going the 'green way' may affect the project schedules. This was perhaps the case for the CII-Godrej GBC building because it was the first time that a green building rating tool was being applied in the country. The design in this case took about one-and-half years, while the construction was completed in about nine months!

Thanks to the green building movement, there has been immense capacity building in the country. Now, there is absolutely no difference in the time required for constructing a green building and that of a normal building. The time schedule for the rating can be synchronized with that of the building. This has been amply demonstrated in buildings like Wipro in Gurgaon and Grundfos in Chennai.

Perception 3: Green buildings have to be air-conditioned

Reality

Green building concepts and the LEED rating can be applied for non-air conditioning buildings. It has been applied on three such buildings in India—IGP office, Gulbarga; the Royal Engineering College, Hyderabad; and LIC office, Shimoga.

While performing the energy analysis using software tools, it was shown that such buildings will use the same cooling system both in the baseline and the proposed designs. This ensures that the building is recognized for any of the other energy efficiency measures incorporated, such as in the envelope, lighting, and roof insulation. This kind of an approach also ensures that an apple-to-apple comparison is made while evaluating two green buildings, whether conditioned or not.

HUDA – ANNEXE – II, Secunderabad
Naturally ventilated Green Certified Building

Table 2 Declining initial incremental cost over years.

Building	*Year awarded*	*Built-in Area* (Sqft)	*Rating Achieved*	*% increase in cost*	*Payback* (Yrs)
CII-Godrej GBC, Hyderabad	2003	20,000	Platinum	18%	7 years
ITC Green Centre, Gurgaon	2004	1,70,000	Platinum	15%	6 years
Wipro, Gurgaon	2005	1,75,000	Platinum	8%	5 years
Technopolis, Kolkata	2006	7,20,000	Gold	6%	2 years
Spectral Services Consultants Office, Noida	2007	15,000	Platinum	8%	4 years
HITAM, Hyderabad	2007	78,000	Silver	2%	3 years

Lessons from past experiences

With about 360 green buildings coming up in the country, there have been some key learnings in applying the IGBC and LEED India rating systems. A few of them are the following.

- Have the commitment of the entire design team to deliver the rating. Define the role and accountability of each design member. This can be a good strategy to ensure easy implementation.
- Conceive green by design. Otherwise, the projects may not be able to apply for certain credits. For example, it would be almost impossible to achieve daylight credit if the depth of the building has been designed more than 4–5 m.
- Freeze the baseline costs right at the beginning so as to realistically evaluate incremental cost due to green aspects. Otherwise, green design can be an easy scapegoat to account for incremental cost due to other factors.

- Use energy simulation tool right at design stage to decide on the material and equipment. If this is not taken care of initially, it may turn out to be an academic exercise.
- Certain material related credits, such as low VOC paints, adhesives, and sealants, appear easy. So, a few construction-related credits like managing construction waste flush out. But these require close monitoring and proper documentation. Otherwise, a project can lose credits on these.

Conclusion

The green building experiences in India have been exciting and challenging. Since its introduction in 2001, the green building concept has emerged as a very useful tool in designing sustainable buildings. The IGBC and LEED India rating systems have been launched to facilitate easier adoption of green building concepts suited to the Indian context.

Some of the government and public sector buildings registered/ awarded green building rating

- HMDA, Hyderabad
- Police Bhavan, IGP Office, Gulbarga
- Ministry of External Affairs, New Delhi
- ISRO, Bengaluru
- ONGC, New Delhi
- ONGC, Dehradun
- ONGC, Mumbai
- IRICEN (Indian Railways Institute of Civil Engineering), Pune
- Orissa Industrial Infrastructure Development Corporation, Orissa
- National Remote Sensing Authority, Hyderabad
- BESCOM (Bangalore Electricity Supply Company Ltd),Bengaluru

The increase in LEED India projects is a clear signal that the Indian building industry is becoming more environment-conscious. With this experience and increasing participation of all stakeholders in the green building movement, IGBC started launching indigenous rating programmes for specific building types. IGBC Green Homes and IGBC Factory Building rating programmes have been very well-received by the industry. IGBC is working further to launch rating programmes for existing buildings, SEZs (special economic zones), green cities, and schools in the years to come.

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Inviting articles for Akshay Urja

The need to have a sustainable supply necessitates the exploitation of available energy sources, and among these, renewable resources are at the forefront. It is now an established fact that RE (renewable energy) can be an integral part of sustainable development because of its inexhaustible nature and environment-friendly features. RE can play an important role in resolving the energy crisis in urban areas to a great extent. Today RE is an established sector with a variety of systems and devices available for meeting the energy demand of urban inhabitants, but there is a need to create mass awareness about their adoption. *Akshay Urja* is an attempt to fulfil this need. 20 000 copies are being disseminated in India and abroad.

Akshay Urja publishes news, articles, research papers, case studies, success stories, and write-ups on RE. Readers are invited to send material with original photographs and statistical data. The photographs should be provided on hard copy or as high resolution (minimum 300 DPI) files on a CD. *Akshay Urja* will pay suitable honorarium for each published article of about 1500 words and above to the authors. The publication material in two copies, along with a soft copy on CD/floppy/e-mail may be sent to

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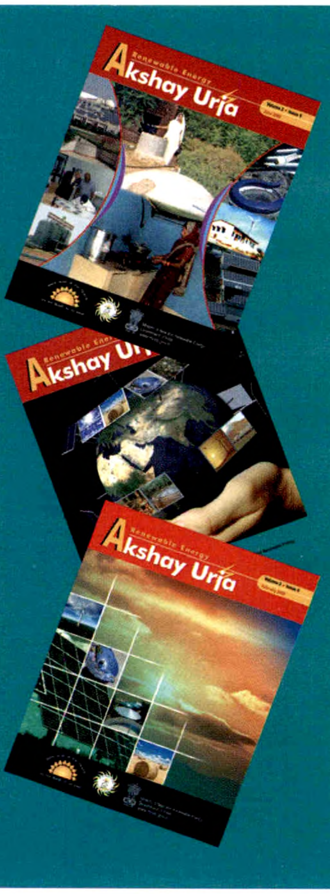


www.mnre.gov.in

WORLD'S LARGEST SOLAR STEAM COOKING SYSTEM AT SHRI SAIBABA SANSTHAN TRUST, SHIRDI

The world's largest solar steam cooking system installed at Shri Saibaba Sansthan Trust, Shirdi, for cooking food for 20 000 pilgrims every day was inaugurated by Dr Farooq Abdhullah, Honourable Minister of New and Renewable Energy on 30 July 2009. Shri Vinay Kore, Minister of Non Conventional Energy, Government of Maharashtra, and Shri Radha Krishan Vikhe Patil, Minister of Education, Law, and Justice, Government of Maharashtra, were also present in the function. The function was attended by over 200 people.

Dr Farooq Abdullah, Hon'ble Minister for New and Renewable Energy, inaugurates the world's largest solar steam cooking system

The system installed and completed at Shirdi is a good example of proper planning, as the solar system was deliberated at the design stage of the Sansthan's new kitchen for pilgrims. Planning the system at the design/construction stage has helped the Sansthan to avoid pipeline exposure, giving the building a good aesthetics. The system has been designed and installed by M/s Gadhdia Solar Energy System Pvt. Ltd, Valsad, Gujarat, and has been completed within a short time of 10 months.

The system comprises of 73 automatically tracked solar dishes, each of 16 sq m aperture area, placed in series and parallel combination. Every day, about 3500 kg of steam at desired pressure and temperature is being generated from this system, which is sufficient to cook food for 20 000 people. The system has been designed in such a way that even if electricity is not available to run the feed water pump for circulating water in the system, it can generate sufficient amount of steam to cook food for the required number of people. It has a steam header connected to a large number of receivers where water can be stored in the morning when electricity is available. This helps in storing the generated steam in the header for quite some time to be used later for cooking in the kitchen. So during day time, it runs on 'thermo-syphon principle' without the need of electricity. The system is connected to the Sansthan's conventional boiler, which runs on LPG (liquefied petroleum gas) to take care of cloudy and non-sunshine hours. The total cost of the system is Rs 13.3 million and the MNRE (Ministry of New and Renewable Energy) has provided a subsidy of Rs 5.84 million to the Sansthan through MEDA (Maharashtra Energy Development Agency). The system is expected to save around 0.1 million kg of LPG every year, which is equivalent to Rs 2 million approximately.

In 2001, a smaller system for 3000 people with 40 dishes each of 10 sq m area was installed at their old 'prasadalaya', which served the Sansthan adequately. The present system has been installed based on the satisfactory experience of the old system. The sansthan has utilized the improved technology of the solar dishes, which are 6 sq m more in size than the previous ones. This has reduced the covered area for installation of the system as well as the operational and maintenance requirements.

After the function, Dr Abdullah and the Secretary of MNRE had detailed discussions with the state ministers from Maharashtra and senior officials of Shri Saibaba Sansthan Trust in which he emphasized that the Sansthan should explore the maximum use of renewable devices and systems so as to make Shirdi an eco/green city. This would set an example for other institutions and cities/towns. He also emphasized that the Government of Maharashtra should take an initiative to promote the use of renewable energy devices and systems in all technical institutions of the state that consume a large amount of conventional fuel for lighting, heating, and cooking food for their students.

DECODING THE ENERGY CONSERVATION BUILDING CODE

SUPARNA MUKHERJI
Associate Editor, TERI Press, New Delhi

Buildings are one of the largest end users of energy. They represent 40% of the primary energy use globally. And if the energy consumed in manufacturing materials like steel, cement, aluminium, and glass used in building construction is included, the number grows to more than 50%. According to the World Business Council for Sustainable Development, carbon could be reduced globally by 715 million tonnes by 2010 by simply improving the energy efficiency in buildings and appliances.

Yet, the energy consumption in buildings is projected to rise substantially in the fastest growing countries, such as India. The situation is made worse by the energy inefficiency of these buildings. For instance, most commercial buildings have EPI (energy performance index) of 200 to 400 kWh/sq m/year, while similar buildings in North America and Europe have EPI of less than 150 kWh/sq m/year. Even though energy-conscious building design has been shown to reduce EPI to 100 to 150 kWh/sq m/year in India, the development of such buildings is restricted to environmentally sensitive corporates only. Large scale energy-efficient building design is limited due to split incentives among the stakeholders, such as builders and tenants.

Seeing this lack of energy efficiency, the Government of India launched the National Mission on Sustainable Habitat, as part of the NAPCC (National Action Plan on Climate Change). It led to the formulation of the Energy Conservation Act 2001, which provides for the establishment of state energy conservation agencies to plan and execute programmes. The Act further led to the formation of the BEE (Bureau of Energy Efficiency) in March 2002, which launched the ECBC (Energy Conservation Building Code).

The ECBC was developed in 2006 and issued May 2007. For the purpose of the ECBC, the definition of a building is as mentioned in the Energy Conservation Act 2001—'any structure or erection or part of a structure or erection...which is having a connected load of 500 kW or contract demand of 600 kVA and above, and is intended to be used for commercial purposes'. Other DSM (demand side management) programmes target residential buildings with lower connected loads. The objective of the ECBC is to reduce the baseline energy consumption by supporting adoption and implementation of efficiency measures in buildings.

Average energy consumption in buildings

HVAC	55%
Lighting	14%
Electronics	27%
Others	4%

http://www.bee.gov.in/ecbc/NationalECBCAwarenessProgrammeJun-Jul2009/01-ECBC-SanjaySeth.pdf

It puts forth requisite specifications for building materials and systems, so that the end product (the building) is assuredly energy-efficient. It has been developed to account for five different climatic zones of India, particularly for envelope component requirements. It covers minimum requirements for building envelope, mechanical systems and equipment, including HVAC (heating, ventilation, and air conditioning) system, interior and exterior lighting system, service hot water, electrical power, and motors in order to achieve energy efficiency in different climate zones.

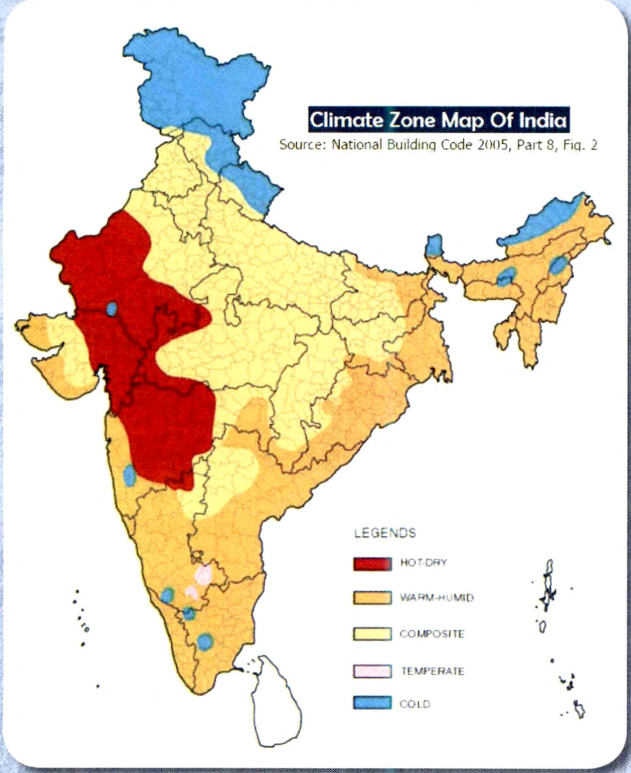
The provisions of this code do not apply to buildings that

- do not use either electricity or fossil fuel;
- equipment and portions of building systems that use energy primarily for manufacturing processes;
- multi-family buildings of three or fewer stories above grade, and single-family buildings.

Moreover, if the code is found to conflict with safety, health, or environmental codes, the safety, health, and environmental codes shall take precedence.

It is not mandatory in the first three years, but will become so in 2010 to allow the necessary implementation capacity to be developed. The code will be mandatory for all new buildings (commercial buildings or complexes) with a connected load of 500 kW or more, or a contract demand of 600 kVA or greater. It will also apply to buildings with a conditioned floor space of 1000 sq. m or greater.

There would be three ways of being compliant with the ECBC. First, through a prescriptive approach—all minimum



Climate Zone Map Of India

Source: National Building Code 2005, Part 8, Fig. 2

standards for separate components must be met. Second, the envelope and lighting system would be assessed through a systems performance criterion. Other components would have to meet the minimum requirements. Third is the energy cost budget method—the setting up of the whole building target energy use and trade off between systems.

State and municipal governments must implement the code, while state governments are allowed to modify it, if necessary, to account for local climatic conditions. In February 2008, an ECBC tip sheet and technology atlas were distributed to developers, architects, engineers, and other building energy efficiency professionals. In addition, awareness programmes on the code are organized around the country.

Scheme for rating of buildings

The Star Rating Programme for buildings is based on actual performance of the building in terms of specific energy usage (kWh/sq m/year). This programme would rate office buildings on a 1–5 Star scale, with 5 Star-labelled buildings being the most efficient. Five categories of buildings – office buildings, hotels, hospitals, retail malls, and IT Parks – in five climate zones in the country have been identified. Office buildings (air-conditioned and non-air-conditioned) have been categorized in the following three climatic zones—warm and humid; composite; and hot and dry. It will be subsequently extended to other climatic zones and building types.

Scheme for participation

Buildings with a connected load of 500 kW and above can participate in the scheme. The application for each building shall be accompanied by non-refundable registration fee of Rs 100 000. EPI in kWh/sq m/year in terms of purchased and generated electricity would be divided by built up area in sq m, excluding basement and parking areas. The total electricity would not include electricity generated from on-site renewable sources such as solar photovoltaic. Energy performance would be judged after completion of a year of operation with full occupancy of the building.

Check testing and verification

The BEE will conduct regular sample checks for information provided by the building owner and the EPI. The user of the label will have to make available the drawings of the building/facility. Information of the defaulters would be put out in the public domain, including an advertisement in newspaper, together with withdrawal of the authority to use the label. Provision for challenge-testing the label contents by other star-rated building owners have been made in the scheme.

SOURCE: WWW.BEE-INDIA.NIC.IN

GROWTH PROFILE OF INDIAN COMMERCIAL SECTOR

- Demand for office space in India is driven by the increasing share of the services sector in the Indian economy.
  - Office space supply shifting from central business districts to secondary centres (office and IT parks)
  - Modern office buildings in newly developed areas enable the higher quality standards that are essential for IT services
  - All India office market
    - 70% by IT services companies (more than 7000) in India.
    - 15% by financial service providers and pharmaceutical sector.
    - 15% by other sectors.
    - Office stock must increase nearly 20 million sq ft per year in New Delhi, Mumbai, and Bangalore to keep pace with the growing demand.
    - Conservative estimate for India is approximately 55 million sq ft per year.
- Shopping centres/malls
  - By the end of 2008, the estimated space in 257 centres was about 79 million sq ft in 15 large cities of India.

GREEN BUILDING INITIATIVES

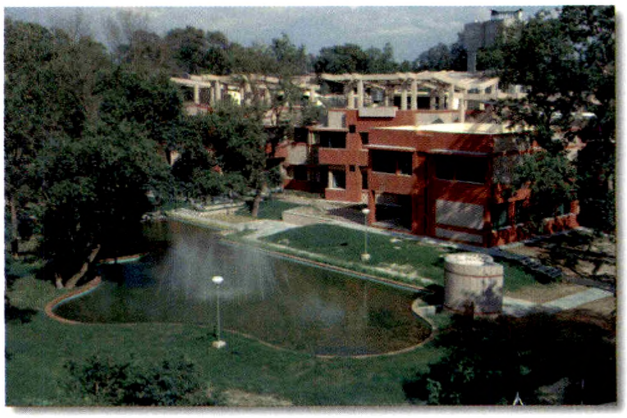
The green building movement has gained momentum in India. Several organizations, both big and small, are adopting energy-efficient and environment-friendly designs. The main aims are to minimize the demand for non-renewable resources, while maximizing the utilization efficiency of these resources when in use; maximize the reuse and recycling of available resources; and utilize renewable resources.

Here are a few projects – institutional, commercial, and residential – which have incorporated the 'green building' concept in their designs. They have also registered under the GRIHA (Green Rating for Integrated Habitat Assessment) to be evaluated and rated at a national level. And with this, they are set become the pioneers of India's green building movement.

GREEN BUILDING INITIATIVE 1

Earth System and Environment Science Engineering Building, IIT Kanpur

Earth System and Environment Science Engineering Building is a research facility located in the IIT campus at Kanpur. The building, as the name suggests, would house laboratories and other facilities for various disciplines of the environment sciences, like Atmospheric, Oceanographic, Earth Sciences, and so on. The architecture of the building has been designed around the existing vegetation so as to not to disturb the natural surroundings. Green measures, such as adoption of solar passive, water conservation, rainwater harvesting, and utilization of renewable energy, would be incorporated.



GREEN BUILDING INITIATIVE 2

Haryana Technology Park (Green Spaces), Faridabad

Green Spaces (Haryana Technology Park, Faridabad) is a notified SEZ (Special Economic Zone) on National Highway 2. It would be ready for occupation by 2012 as a fully furnished and serviced facility with retail and recreation centres, food courts, 100-bedroom guest-house, green data centre, helipad, parking, and office space with 1.75 million sq ft of BUA to run on a 24×7 basis with day and night rentals and hot desks for 18 000 persons. Its estimated cost is $263 million. It has achieved over 75% energy savings over an A Class building and there are plans to further improve upon this before commencing construction.

It is a reference 'Flagship Project' of the Asia Pacific Partnership—an inter-governmental partnership of US, Canada, Australia, Japan, South Korea, China, and India. US Department of Energy is providing special support through its National Laboratories—Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, and National Renewable Energy Laboratory. It is being built in a technology partnership with ABB, GE, IBM, ITT, Carrier, Polycom, Interface, Sony, Toshiba, and others.

GREEN BUILDING INITIATIVE 3

S P Infocity, Manesar

The proposed development would be a campus model for multi-tenanted Information Technology Park in Manesar, with special stress on Business Process Outsourcing leasers/purchasers. Sky Scape Developers Ltd, a SPV of Shapoorji Pallonji Co. Ltd, has been allotted this institutional plot, which measures about 9.44 acre, by HSIIDC (Haryana State Industrial and Infrastrcture Development Corporation).

Total development is planned for four buildings. In the first three blocks, the IT office area will be accommodated, which will have configuration of ground + 5 storeys, ground + 8 storeys, and ground + 10 storeys, respectively. Last block consists of a mix of IT, commercial, and retail areas in the lower block and residential/service apartment on the upper block. Configuration of this building is ground + 11 storeys for lower block and 7 storeys in the upper block. Three basements are planned for in the full area of the plot, except the setback area, to accommodate the parking and services of the buildings.

The finish of the building from the outside will be a combination of heat-reflecting glazing in suitable framing, Aluminium Composite Panels, and permanent finished surface. Glazed aluminium windows and doors will also give good aesthetic look to the building. The common areas are to be finished in granite and marble. The floors on different blocks are designed in such a way that the area can be sub-divided into separate floor plates for the purpose of renting. Each of the floor plates would have independent toilets and AHU (air handling unit), which would help the rentable plates to function absolutely independently.

Sub-station: Power supply is to be received on HT (high tension) 11 kV. Suitable voltage step down transformer and 100% power backup is planned through synchronized DG sets. Energy-efficient air conditioning systems will be provided in all individual and common areas except the basement and fire staircases. Each rentable area will have its own AHU and chilled water connections. HFC-R-134A, an environment-friendly refrigerant is being considered. An efficient sewage and water treatment plant is also planned. The treated water from the STP shall be used for the make-up water in HVAC system, as well as for the flushing in the toilets. Rainwater harvesting, as per byelaws, would also be done. External development of the plot includes the soft and hard landscape, apart from the proper roads and pathways as per traffic planning.

Suzlon Energy Limited, Hadapsar, Pune

GREEN BUILDING INITIATIVE 4

Suzlon Energy Ltd is the flagship company of the dynamic Suzlon Group, which specializes in total solution for wind power generation. The Suzlon campus, which will accommodate 2500 members, has been designed respecting nature, evolving an energy-efficient built form, and comforting the end-users who shall spend many hours in these enclosed spaces. The philosophy imbibed in the entire campus is that of an urban village. Features like horizontal spaces, instead of linear structures, are built so as to establish close functional links using latest technology and quality standards. The entire campus is designed to make it cluster-free, modern, and user-friendly. The corporate campus is being developed on approximately 11.72 acre of land, with two major activities office complex and Corporate Learning Centre. The total built-up area is around 600 000 sq ft and the basement built-up is 220 000 sq ft, consisting of parking, storage areas, and back-up services.

GREEN BUILDING INITIATIVE 5

The Doon School

The school has taken the initiative to start a long-term process towards self- sufficiency in energy, water, and organic fertilizer by opting for sustainable sources of energy and waste recycling. This would serve the dual purpose of having amongst India's first 'green' school campuses and showcasing the importance of sustainability to its students by making the responsible use of scarce resources a part of their everyday life. It seeks to bring up its students in a system that befriends nature and respects the environment, even as the schools needs are met by incorporating the ongoing advance of sustainable technology that will be a part of the movement towards building a viable alternative to fossil fuels and the control of emissions.

As a part of its drive to replace many of its old buildings (which were declared unfit for habitation), it has taken the decision to design them as per an architectural vision statement that incorporates standards that shall see the Art School complex (comprising of the Art School and the Art Masters house) and six teachers houses (adjoining the main playfield) built as TERI-GRIHA-rated habitats. Consequently, the school has ensured that the entire building process from demolition of the old buildings, through construction to occupancy be done as per GRIHA guidelines to achieve negligible environmental impact and a minimal ecological footprint in the long run. For instance, by changing the building envelope materials alone, the requirement for artificial space conditioning systems (cooling or heating) has been reduced to a negligible minimum. This translates into a drastic reduction in electricity consumption that may have been required for air conditioning or heating under ordinary conditions.

The buildings shall also incorporate solar thermal systems to fulfill their hot water requirements and water and waste management processes for reduced environmental impact. The school proposes to install solar thermal systems on all existing campus buildings as well as tap alternative/renewable sources of energy, such as biomethanation and biomass gasification, at a campus level wherever possible.

Office of Public Works Department, Nashik

GREEN BUILDING INITIATIVE 6

The PWD (Public Works Department) of Nashik owns a land measuring 7740 sq m on Sir Visvesverayya Marg in Nashik, while some of the PWD offices are in very old buildings. The old structures have only one floor, and due to their overage and dilapidated condition, considerable expenditure is incurred on their maintenance. PWD has decided to construct a new building by dismantling the entire old structure on this land. Proposed office building shall be constructed as a green building as per TERI GRIHA.

The new building will be a G + 3 structure, with about 6200 sq m built-up area. The new building plan will include green concepts based on solar passive architecture with sufficient floor-to-floor height to facilitate maximum daylight and good ventilation. All these measures would minimize the energy consumption. The rubble obtained by dismantling the old structures shall be utilized for the wind tower, and the other building material will also be utilized in the building work. Rainwater will be harvested, stored, and utilized for flushing in the toilet blocks and for the wind towers. The drainage water will be treated with root zone technique. The materials that will be used are fly ash bricks, low e-glass, low VOC paints, and so on. Other efficient features like waterless urinals/urinals with sensor, insulation paint, electronic ballast, use of CFLs and T-5 tubes, solar panels, wind mills, and green generator are being considered. As the building is a non-AC building, wind towers will be provided for air-cooling.

The 3rd Renewable Energy India 2009 Expo

'Renewables...empowering India' was the theme of the 3rd Renewable Energy India 2009 Expo, and it showed that renewables truly can. The sheer scale of the event – South Asia's largest – was a proof of this. The expo, dedicated to the universal cause of sustainable development, was organized from 10–12 August 2009 at Pragati Maidan, New Delhi. A total of 12 665 trade visitors and 1504 conference delegates from across the globe visited the Expo to meet the 386 exhibitors from 27 countries. The event, spread over 15 000 sq m, was a host to country pavilions from Germany, United States of America, and high-level trade delegations from Bangladesh, China, and United Kingdom. The expo offered an excellent opportunity for the interaction amongst key decision-makers, government officials, venture capitalists, equity investors, technocrats, engineers, and the media.

The concurrent 3-day international conference module attracted 140 domestic and international speakers to share their expertise on strategic issues involving regulatory framework, global markets and policy drivers, technologies, and other challenging issues related to renewable energy industry.

In the expanded format covering solar, wind, bio, small hydro, geothermal, cogeneration, energy efficiency, and EV (electric vehicles)/HV (hybrid vehicles), the event also hosted several parallel events, including 'CEO Round Table', in which industry leaders provided insights into the renewable energy sector, investment outlook, and policies for future growth. Green Jobs Fair 2009 and workshops by the SESI (Solar Energy Society of India), German India Cluster Network, and Structural Solutions are other key highlights of the event. A youth summit was also organized. The Youth Entrepreneurial Green Awards 2009, sponsored by Garrad Hassan and Partners Ltd, UK, was organized with the support of IYCN (Indian Youth Climate Network) to encourage outstanding projects undertaken by the Indian youth in the field of renewable energy.

Shri Deepak Gupta, Secretary, MNRE (Ministry of New and Renewable Energy) acknowledged the renewed interest in developing alternative energy against the backdrop of depleting fossil fuels. He also stressed on the need to have a coherent roadmap to fully leverage the huge but latent potential of renewable energy in India. He further announced that India will be host to the next international conference—DIREC (Delhi International Renewable Energy Conference) at New Delhi/NCR (national capital region) during 27–29 October 2010. Seeing the overwhelming response to the 3rd Renewable Energy India 2009 Expo, the MNRE expressed its confidence in the competence of the organizer to manage the global forthcoming mega event on renewables.

IREDA's new energy-efficient corporate office

IREDA's corporate office has recently shifted to August Kranti Bhavan, Bhikaji Cama Place, New Delhi. And the new office is not only well-situated but is also energy-efficient.

August Kranti Bhavan is a 10-year-old building, constructed and promoted by HUDCO (Housing And Urban Development Corporation Ltd) for housing offices and commercial shops. The new office complex is free from the daily hustle-bustle of the commercial activities and yet, conveniently near for availing various facilities offered by the Bhikaji Cama commercial complex.

While planning for the interiors of the new office complex at August Kranti Bhavan, IREDA's management emphasized the need for making the office green and energy-efficient to the maximum possible extent. As the building was already constructed, making the office 'green' was a difficult task because neither the orientation nor the exterior of the building could be altered. Even with these limitations, IREDA managed to make the office eco-friendly to a great extent by adopting various strategies, including

- Use of energy-efficient products and systems
- Optimization of Energy Usage through Controls
- Energy Management System

Strategy 1 – Use of energy-efficient products and systems

Reduction of thermal gain through the use of insulated glazing in windows and maximization of day light use

Large external double-glazed insulated windows have been installed with high performance nano-coated glass with low U-value (1.86 W/m^2 deg K), low shading co-efficient (0.41 W/m^2 deg K), and high visual light transmittance (47%) to reduce heat gain through windows. This also helps to have high light-penetration, which minimizes the use of artificial light.

Reduce thermal gain through the roof by insulation

Under-deck insulation of 50 mm thermocoal has been used to minimize heat gain through the roof, resulting in lower HVAC loads.

Use of energy-efficient light fittings and lamps

Energy-efficient light fixtures, with energy saving T-5 and CFL lamps, have been installed to reduce the lighting load, without comprising on the luminosity level.

Use of energy from renewable sources

Solar hot water system of 200 lpd (litres per day) capacity has been installed for use in the pantries and toilets.

Installation of energy-efficient HVAC system

VRF (Variable Refrigerant Flow) System type of air-conditioning system has been installed, which is currently, the most efficient and less power consuming air-conditioning system. It consumes about 20%–30% less power, as compared to any other conventional system. The volume or flow rate of refrigerant is matched to the required heating or cooling loads, thereby saving energy and providing more accurate control. For supply of fresh air and exhaust of foul air, HRV (Heat Recovery Ventilation) Units have been provided, which reduce the load of fresh air by up to 60%, resulting in further reduction in the overall air-conditioning load by 10%–15%.

Strategy 2 – Optimisation of energy usage through controls

Lighting control

- Occupancy sensors for cabins, meeting rooms, toilets, and so on have been provided so that the lights get automatically switched off when these spaces are not occupied.
- Active and passive lighting circuits to minimize power consumption on lighting on low occupancy days.
- Separate circuits for lighting/power/HVAC for separate metering and monitoring.
- Software for energy monitoring and generation of historical energy consumption data.
- Link to access control system for monitoring energy consumption/sqm/person at any given point of time.

Plumbing fixtures with sensor control

- Plumbing fixtures with automatic sensors to save water, thereby reducing energy consumption when pumping less water.

HVAC control

- To account for variation due to load, climate, and occupancy schedules.
- Automated control of temperature, humidity through VFD (variable frequency drives).

Strategy 3 – Energy Management System

The system improves management of facilities, and reduce electricity use. It assists corporate management in understanding energy consumption pattern and actively managing energy use and cost by:

- Reduction in specific energy consumption
- Reduction in distribution loss
- Reducing peak demand
- Energy resource planning
- Removal of inefficient equipment
- Predictive maintenance
- Root cause analysis
- Measurement and verification
- Improving equipment performance.

With these initiatives, IREDA's corporate office has set an example for each and every organization in India.

Inviting advertisements for Akshay Urja

Akshay Urja is widely circulated to various stakeholders of renewable energy. *Akshay Urja* invites advertisements (in colour) from interested organizations, manufacturers, institutions, etc. The advertisement tariffs are as follows.

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Full Page	25 000

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Editor, *Akshay Urja*
Ministry of New and Renewable Energy, Block - 14, CGO Complex, Lodhi Road, New Delhi – 110 003
Tel. +91 11 2436 3035 or 2436 0707 • Fax +91 11 2436 3035 or 2436 1298 • E-mail aktripathi@nic.in

ALTERNATIVE FUELS

A	C	I	Z	U	F	E	O	D	S	G	P	A	L	V	U	J	Z	C	L	V	J	A	H	X	D	I	A	Y	I
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D	K	Y	I	T	N	S	W	S	M	W	V	G	I	W	U	X	M	P	I	R	Y	C	M	Q	X	X	H	W	Q

biodiesel	hydrogen
compressed natural gas	liquefied petroleum gas
electricity	methane
ethonol	methanol
flexible fuel vehicle	MTBE
fuel cells	propane
hybrid	

Send in your contribution to the following address, which will be published in the forthcoming issue of *Akshay Urja*.

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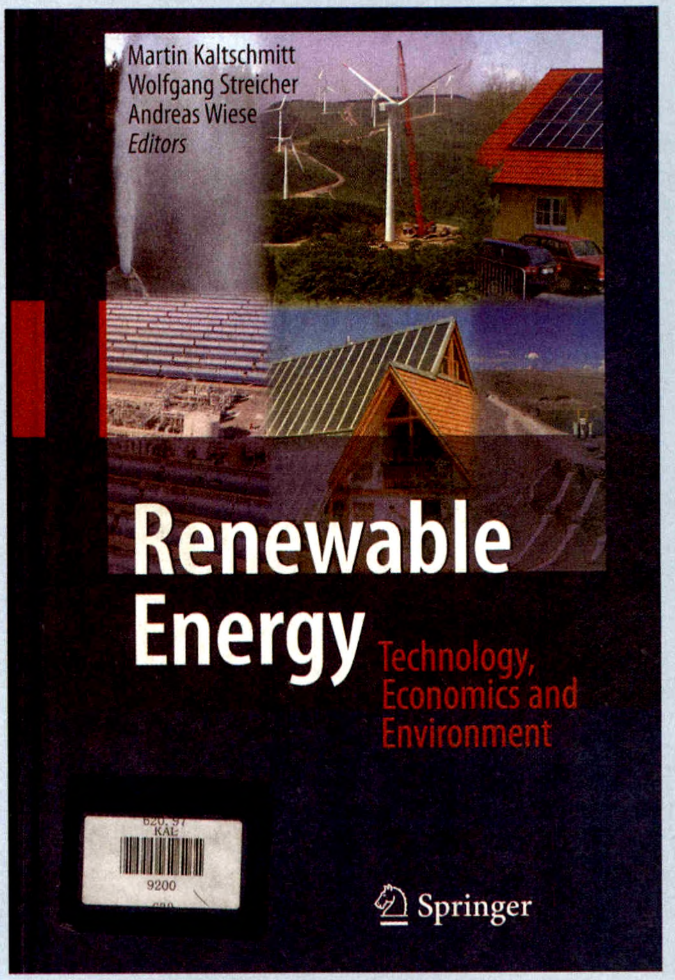
RENEWABLE ENERGY

technology, economics, and environment

Renewable sources of energy have always been considered as a better alternative to fossil fuels. Not only are they environment- and climate-friendly, but they can also be used repeatedly without depletion. In addition, the considerable increase in the prices of fossil fuels in the global energy markets in the last few years has put more stress on the multiple possibilities of utilizing renewable energy sources.

In this context, *Renewable energy: technology, economics, and environment* outlines and discusses the main fields of renewable energy applications. It presents the physical and technical principles of the promising ways of utilizing renewable energies. The book outlines the main characteristics of the available renewable energy streams. It talks about the technologies of heat provision from passive and active solar systems, ambient air, and energy from shallow and deep geothermal energy sources. The book also addresses the processes of electricity generation from solar radiation (photovoltaic and solar thermal power plant technologies), wind energy, hydropower, and geothermal energy. In addition, there are brief discussions on the possibilities of harnessing ocean and biomass energies. The most important technologies for exploiting fossil energy carriers for the provision of heat and electricity are also briefly described and characterized, setting a base standard for evaluating energy provision options based on renewable energy sources.



Renewable Energy: Technology, Economics and Environment
Edited by Martin Kaltschmitt, Wolfgang Streicher,
and Andreas Wiese 2007
New York: Springer Berlin Heidelberg • 564 pp
ISBN: 978-3-540-70947-3 • Price: €69.95

The book also provides crucial data and parameters for the economic and environmental assessment of the renewable energy utilization options. This, supported by 270 figures and 66 tables, helps us to judge the potential and limitation of these options. Key figures that allow for a classification of these options according to the demands of the energy system are also elaborated.

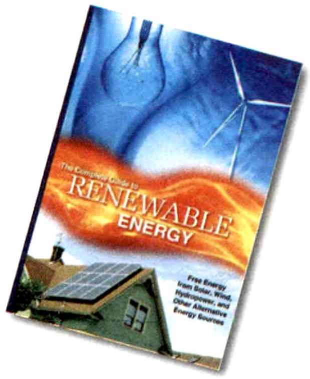
In a nutshell, the book provides a survey of the most important renewable energy sources; deals with technological as well as with economical and environmental aspects; and provides parameters and data sheets to provide useful estimates of changes and limits of renewable energy sources.

Reviewed by
Suparna Mukherji, TERI Press

Renewable Energy Made Easy: Free Energy from Solar, Wind, Hydropower, and Other Alternative Energy Sources

Craddock D. 2008

USA: Atlantic Publishing Company



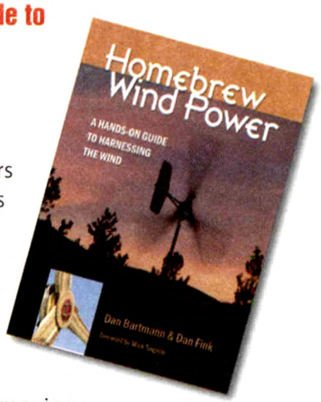
This book has everything one needs to know about alternative energy sources. It talks about the availability, aesthetics, environmental and social considerations, and longevity issues of these energy technologies, and is easy to understand. This book will serve as a guide to more efficient buildings. The aim is to show how a country can improve its energy efficiency, reduce oil dependence, improve energy security, and reduce the health and environmental impact of the energy system.

ISBN: 978-1-6013824-0-5 • Price: $24.95

Homebrew Wind Power: A Hands-on Guide to Harnessing the Wind

Bartmann D, Fink D, and Sagrillo M. 2009

USA: Buckville Publications LLC



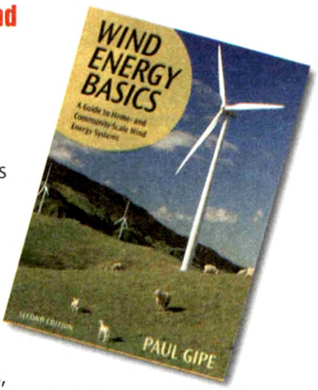
In this ground-breaking book, the authors provide step-by-step, illustrated instructions for building a wind generator in a home workshop and then, installing it in an off-grid home electrical system. Even if one does not plan on building a turbine, this book is packed with valuable information for anyone considering wind energy. It covers the basic physics of how the energy in moving air is turned into electricity, and most importantly, it gives a realistic idea of what wind energy can do and what it cannot.

ISBN: 978-0-9819201-0-8 • Price: $39.95

Wind Energy Basics: A Guide to Home- and Community-Scale Wind-Energy Systems

Gipe P. 2009

Chelsea Green Publishing

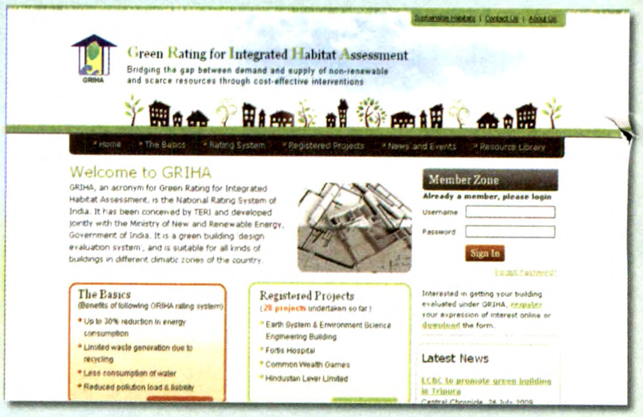


The availability of clean, renewable power is without question going to be the defining challenge and goal of the 21st century, and wind will lead the way. Internationally acclaimed wind energy expert Paul Gipe explains why and how wind power can not only replace the lion's share of oil-, coal-, and natural gas-fired electrical plants, but also add enough extra power capacity to allow for most of the cars to run on electricity. The book explains why such a solution is eminently doable and will have the capacity to resuscitate small and regional economies. Wind Energy Basics offers a how-to for home-based wind applications, with advice on which wind turbines to choose and which to avoid. The book guides wind-energy installers through considerations, such as renewable investment strategies, and gives cautionary tales of wind applications gone wrong. And for the activist, the book suggests methods of prodding federal, state, and provincial governments to promote energy independence.

ISBN: 978-1-6035803-0-4 • Price: $29.95

Internet resources ▶▶▶

GRIHA


Sustainable Habitats | Contact Us | About Us
GRIHA
Green Rating for Integrated Habitat Assessment
Bridging the gap between demand and supply of non-renewable and scarce resources through cost-effective interventions
Home
The Basics
Rating System
Registered Projects
News and Events
Resource Library
Member Zone
Already a member, please login
Username
Password
Sign In
Latest News

Welcome to GRIHA

GRIHA, an acronym for Green Rating for Integrated Habitat Assessment, is the National Rating System of India. It has been conceived by TERI and developed jointly with the Ministry of New and Renewable Energy, Government of India. It is a green building 'design evaluation system', and is suitable for all kinds of buildings in different climatic zones of the country.

The Basics

(Benefits of following GRIHA rating system)

- Up to 30% reduction in energy consumption
- Limited waste generation due to recycling
- Less consumption of water
- Reduced pollution load & liability

Registered Projects

(28 projects undertaken so far)

- Earth System & Environment Science Engineering Building
- Fortis Hospital
- Common Wealth Games
- Hindustan Lever Limited

Interested in getting your building evaluated under GRIHA, register your expression of interest online or download the form.

LCBC to promote green building in Tripura

http://www.teriin.org/griha/index.php

GRIHA (Green Rating for Integrated Habitat Assessment) is the National Rating System of India. It is a green building 'design evaluation system', suitable for all kinds of buildings in different climatic zones of the country. It has been conceived by TERI (The Energy and Resources Institute), and developed jointly with the MNRE (Ministry of New and Renewable Energy), Government of India.

The GRIHA website is a storehouse of information on green and sustainable buildings. It not only explains what GRIHA is in great detail, but also explains its basic features, the challenges, the benefits, and the development process. The website guides through the steps of getting a building evaluated under GRIHA, and the procedure for certification—from registration method to fees to documentation required. And it explains the entire GRIHA evaluation process. It also lists the members of the National Advisory Committee and the Technical Advisory Committee of GRIHA. This is not all. The website lists the projects registered under GRIHA, both completed and ongoing, and has sections on news and events. The GRIHA website, in turn, links to the sustainable habitat website http://www.sustainable-buildings.org/. The 'Sustainable Habitats' is a new initiative of TERI, launched to provide niche information about green buildings on a single platform. It showcases best practices used in various eco-friendly buildings, updates on green-rated buildings, latest news, primer on different rating systems, and useful resources to help execute successful green building projects. The collective knowledge-base of this community will be utilized to build a collaborative 'Wiki' of technical terms, to get quick responses to member queries, and to generate opportunities for business networking. So, in a nutshell, the GRIHA website is a focal point for know-how on green buildings and the rating system.

National events

Solarcon India

9–11 November 2009, Hyderabad

Hyderabad International
Conference Centre,
Novotel and HICC Complex
(Near Hitec City)
Hyderabad – 500 081
Tel. 91 80 4050 9200
E-mail msuresh@semi.org
Web www.solarconindia.org

India Nuclear Energy 2009

13–15 November 2009, Mumbai

Bombay Exhibition Centre
Nesco Compound, Goregaon (East)
Mumbai, Maharashtra–400 063
Tel. +91 9825642264
E-mail akashd@ubmindia.com
Web www.indianuclearenergy.net

National Award for Excellence in Energy Management 2009

18–19 November 2009, Hyderabad

Tel. +91 99890 91744
E-mail sriram.bhaskar@cii.in or
bobby.mathew@cii.in

Third Renewable Energy Finance Forum

20–21 November 2009, Mumbai

Maria Ferreiro
E-mail mferreiro@euromoneyplc.com

DSDS (Delhi Sustainable Development Summit) 2010

5–7 February 2010, New Delhi

Taj Palace, New Delhi
Tel: +91 11 24682100/ 4150 4900;
Fax: +91 11 24682144/ 24682145
E-mail: dsds@teri.res.in
Web: dsds.teriin.org/2010/index.php

The first Annual Renewable Energy Business Conference

19–20 January 2010

Intercontinental: The Grand
Mumbai, 204-205
Town Centre, 2nd Floor
Andheri-Kurla Road
Sakinaka, Andheri (E)
Mumbai - 400 059
E-mail leon.dias@informedia-india.com
Web http://informedia-india.com

World Renewable Energy Technology Congress

3–5 March 2010, New Delhi

Hall No. 11, Pragati Maidan
New Delhi–1100
Tel. +91 9971500028/9711433164
E-mail dranilgarg@wretc.in or
anjali@itenmedia.in
Web www.wretc.in

Renewtech India 2010

9–11 March 2010, Pune

Auto Cluster Exhibition Centre,
H-Block, Plot No. C-181
Chinchwad, Pune – 411019
Tel 49 211 38-6000
E-mail k.schlickmann@mco-online.com
Web www.renewtechindia.com

International

Wind Expo 2009

2–4 September 2009, Panama City, Panama

Av. Terranova 1091-2
Guadalajara México
Tel. +52 33 3817 8300
Fax +52 33 3817 8758
Web http://www.windexpo.org/2009/ing/index.html

24th European Photovoltaic Solar Energy Conference & Exhibition (EUPVSEC)

21–25 September 2009, Germany

WIP-Renewable Energies
Conference Secretariat
Tel. +49 89 720 127–35
E-mail pv.conference@wip-munich.de

ISES Solar World Congress 2009

11–14 October 2009, Johannesberg, South Africa

Tel. +27 12 807 7171
Fax +27 86 559 4753
E-mail info@swc2009.co.za
Web http://www.swc2009.co.za/

Solar Power 2009

27–29 October 2009, Anaheim, California, USA

Tel. 1 202 857 0898
Fax 1 202 682 0559
E-mail ebrown@solarelectricpower.org

Congress on Alternative Energy Applications

2–6 November 2009, Kuwait

Dr Salah Almudh'hi
Web http://www.ec2009kuwait.org/

DIREC (Delhi International Renewable Energy Conference)

27–29 October 2010, New Delhi/NCR

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Plot No. 25,27,28,29,
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Greater Noida - 201 308
Uttar Pradesh, India
Web www.indiaexpomart.com

Renewable energy at a glance in India

S.No.	Source/system	Estimated potential	Achievement as on 31 July 2009
I	**Power from renewables**		
A	**Grid-interactive renewable power**	(MW)	(MW)
1	Wind power	45 195	10 464.00
2	Bio power (agro residues and plantations)	16 881	773.30
3	Bagasse cogeneration	5 000	1 155.00
4	Small hydro power (up to 25 MW)	15 000	2461.00
5	Energy recovery from waste (MW)	2 700	59.00
6	Solar photovoltaic power	—	2.00
	Sub total (A)	**84 776**	**14914.30**
B	**Captive/combined heat and power/distributed renewable power**		(MW)
7	Biomass/cogeneration (non-bagasse)	—	175.78
8	Biomass gasifier	—	107.02
9	Energy recovery from waste	—	34.06
	Sub total (B)	**—**	**370.00**
	Total (A+B)	**—**	**15142.53**
II	**Remote village electrification**	—	5 453 villages/hamlets
III	**Decentralized energy systems**		
10	Family-type biogas plants	120 lakh	41.27 lakh
11	Solar photovoltaic systems	50 MW/km^2	120 MWp
	i. Solar street lighting system	—	70 474 nos
	ii. Home lighting system	—	450 000 nos
	iii. Solar lantern	—	730 000 nos
	iv. Solar power plants	—	8.01 MW$_p$
	v. Solar photovoltaic pumps		7148 nos
12	Solar thermal systems		
	i. Solar water heating systems	140 million m^2 collector area	2.90 million m^2 collector area
	ii. Solar cookers		6.57 lakh
13	Wind pumps		1347 nos
14	Aero generator/hybrid systems		0.89 MW$_{eq}$
IV	**Awareness programmes**		
16	Energy parks	—	511 nos
17	Aditya Solar Shops	—	284 nos
21	Renewable energy clubs	—	521 nos
22	District Advisory Committees	—	560 nos

MW – megawatt; kW – kilowatt; MW$_p$ – megawatt peak; m^2 – square metre; km^2 – kilometre square

Renewable Energy

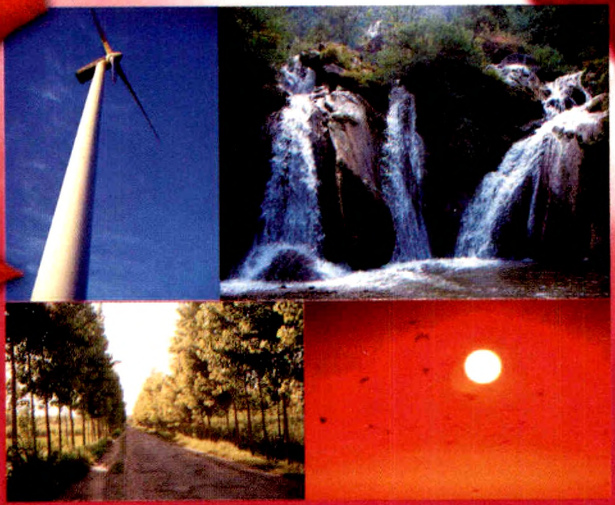
Akshay Urja

Volume 3 ▪ Issue 3
December 2009

अक्षय ऊर्जा से देश विकास

गांव गांव बिजली, घर घर प्रकाश

Ministry of New and Renewable Energy
Government of India
www.mnre.gov.in



Akshay Urja

wishes all its readers a very
Happy and Prosperous New Year !

2010

Renewable Energy
Akshay Urja

Volume 3 • Issue 3 ▪ December 2009

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(Published in English and Hindi)

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FROM THE EDITOR'S DESK

Dear Reader,

The United Nations Climate Change Conference (COP 15) held in Copenhagen in December 2009 could not spell out any legally binding emission reduction targets for the countries of the world. However, many countries and states across the world – like Finland, Brazil, South Korea, US (United States), China, the European Union, Japan, Russia, and India – decided to set up voluntary emission reduction targets. Few among them are even voluntarily spelling out renewable energy targets in a bid to curb carbon emissions.

The Department of Energy and Climate Change of the UK (United Kingdom) has recently outlined a comprehensive long-term plan, which maps out the strategy for generating 30% of UK's electricity from renewables by 2020, up from 5.5% today. It also aims to generate 12% of heat and 10% of transport energy form renewables. In the US, California has proposed an enhanced RPS (renewable portfolio standards) target of 33% by 2020—up from the 2010 target of 20%. Mexico proposes to more than double the share of electricity generated from renewables from the existing 3.3% to 7.6% by 2012. Thus, a consensus is being developed that the utilization of renewable energy can be a tool for curbing carbon emissions.

The Government of India has also given a major fillip to the adoption of renewable energy by launching the JNNSM (Jawaharlal Nehru National Solar Mission), as one of the eight National Missions on climate change, in November 2009. This Mission aims to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible. The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country, both at centralized and decentralized levels. The Mission targets to set up 1100 MW (megawatt) of grid solar power, 7 million sq m of solar collectors, and 200 MW of off-grid solar applications in the first phase (by 2013). By the year 2022, it aims for establishing 20 000 MW of grid solar power, 20 million sq m of solar collectors, and 2000 MW of off-grid solar applications.

However, the true success of this Mission depends solely on the active participation of each and every member of the society. I would request every one of you to come forward and adopt renewable energy in every sphere of your daily life to the maximum extent possible.

To guide you in this endeavour, *Akshay Urja* aims to keep you abreast with the developments in the renewable energy sector of the world. The current issue – with articles on 'Generation of Electricity and Bio Manure through Decentralized Waste Treatment', Development of Solar Community Dish Cookers', 'Biomass Briquettes Replacing Coal and LPG', 'Strategy for Passive Solar Heating of Buildings in Cold Regions of India', 'Empowering Villages by Solar Photovoltaic' – is an attempt in this direction. I am sure that you will find the issue interesting, useful, and informative.

Please continue to show us your support and send us your suggestions and inputs on renewable energy regularly.

With best wishes

AKTripathi

(Dr Arun K Tripathi)
Email: aktripathi@nic.in

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LETTERS TO THE EDITOR

I read the October 2009 issue of *Akshay Urja* and found it very interesting, knowledge-based, and Indianized. I have been interested in photovoltaic energy systems and planning on starting a small company in India in the near future. Thus, I would like to be a regular subscriber of the magazine.

Krishna M Pamidi
380 Abbott Road
Paramus, New Jersy 07652
United States of America

You have been kind enough to send a complimentary copy of *Akshay Urja* Volume 3 Issue 1 August 09 issue for the use of our studious students, brilliant faculty, tireless researchers, and dedicated professionals in the pursuit of their curriculum and research activities.

Since your bi-monthly newsletter is very useful and relevant to our clientele, kindly continue its supply to us by including our name in your mailing list. In case some issues of volume 2 are still available, please mail them to us.

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I am very thankful to the MNRE (Ministry of New and Renewable Energy) for your bi-monthly newsletter *Akshay Urja*, sent to us since 25 September 2006. It is extremely useful for our faculty members, staff members, and B. Tech. students, including those from the fields of Electronics and Communication Engineering, and Electrical and Electronics Engineering. The *Akshay Urja* magazine is encouraging the use of solar energy, wing energy, geothermal energy, biogas, tidal energy, and energy from urban waste. It can ensure energy security and climate protection. It is need of today. There is a vast scope in this field of research, so as to get quick results of high economic value. Thank you!

Ram Nath Maurya
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ram–Bhawanipur, Post–Manadhana,
Kanpur, Uttar Pradesh–209217 I,
Phone-0512-6556102, Ext. 28

I am working on solar energy since the last 4–5 months. In between, I read the *Akshay Urja* in www.mnes.nic.in. I want to read the magazine regularly. All the articles and contents are very useful to me. I am thankful to the MNRE (Ministry of New and Renewable Energy) for the publication this magazine. I am interested to know more about the Akshay Urja Shop Scheme. Please provide the information about the scheme in next issues.

Vipul Goswami
Shri Goswami House,
Bulaki Ki Bari, Subhashpura,
Bikaner, Rajasthan–334001

I have been reading *Akshay Urja* for quite some time now and I must say that the magazine is extremely informative. Renewable energy is just so important for ensuring a sustainable future. Due to the ongoing rapid industrialization, urbanization, and population growth, the gap between the demand and supply of energy has increased in India. Although the energy supply through fossil fuels will continue to play a vital role in India, as the experts predict, there is a large potential for renewable energy resources, which can mitigate the gap between the demand and supply of energy. Thus, there is an urgent need to spread awareness about the advantages of the use of renewable sources of energy among the people of this country, especially the masses as they are the primary users. *Akshay Urja magazine* is a great step by the Ministry of New and Renewable Energy, Government of India, towards this goal. Millions of thanks to the Akshay Urja team and the ministry for publishing such a magazine. Examples like this show that the future can be sustainable.

Ratna Mookherjee
D-26, LIG colony, Dr Ambedkar Nagar
Khanpur, Delhi—110062

The cover story, articles, and the different news regarding renewable energy are very informative and knowledgeable in *Akshay Urja*. I always get very excited to know about the same issues.

Nagendra Kumar Swarnkar
Reader, Department of Electrical
Engineering, JNU, Jaipur

Dear Reader,

Thank you very much for your encouragement. The editorial team of *Akshay Urja* will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvement in terms of content and presentation.

Editor
Akshay Urja

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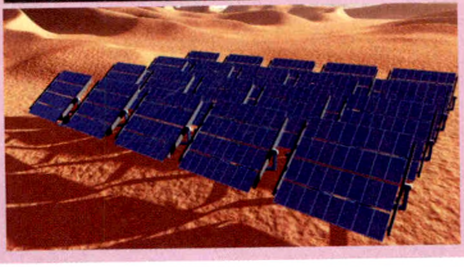

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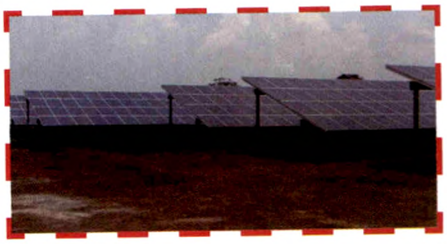

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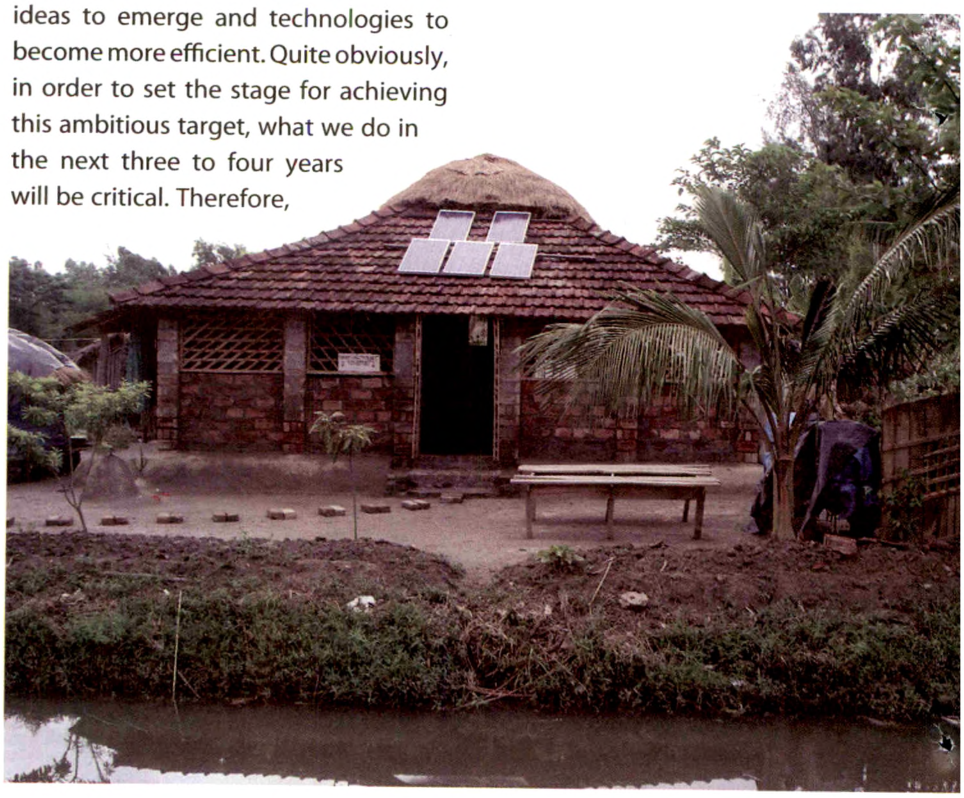
Government announces Jawaharlal Nehru National Solar Mission

Dr Farooq Abdullah, Union Minister for New and Renewable Energy, in a statement in the Parliament on 23 November 2009 said 'the government has approved a new policy on the development of solar energy in the country by launching of the Jawaharlal Nehru National Solar Mission. This is a historic and transformational initiative of the UPA government and I am proud to have the privilege of being assigned the task of overseeing its implementation. The Solar Mission is very much in line with the vision of modern India of Pandit Nehru, which has made India a leading nuclear and space power today.

This Mission is one of the eight key National Missions which comprise India's National Action Plan on Climate Change. It has a twin objective—to contribute to India's long-term energy security as well as its ecological security. We are living in a world of rapidly depleting fossil fuel resources and access to conventional energy resources such as oil, gas, and coal is becoming increasingly constrained. The rapid development and deployment of renewable energy is imperative in this context. And in view of high solar radiation over the country, solar energy provides a long-term sustainable solution.

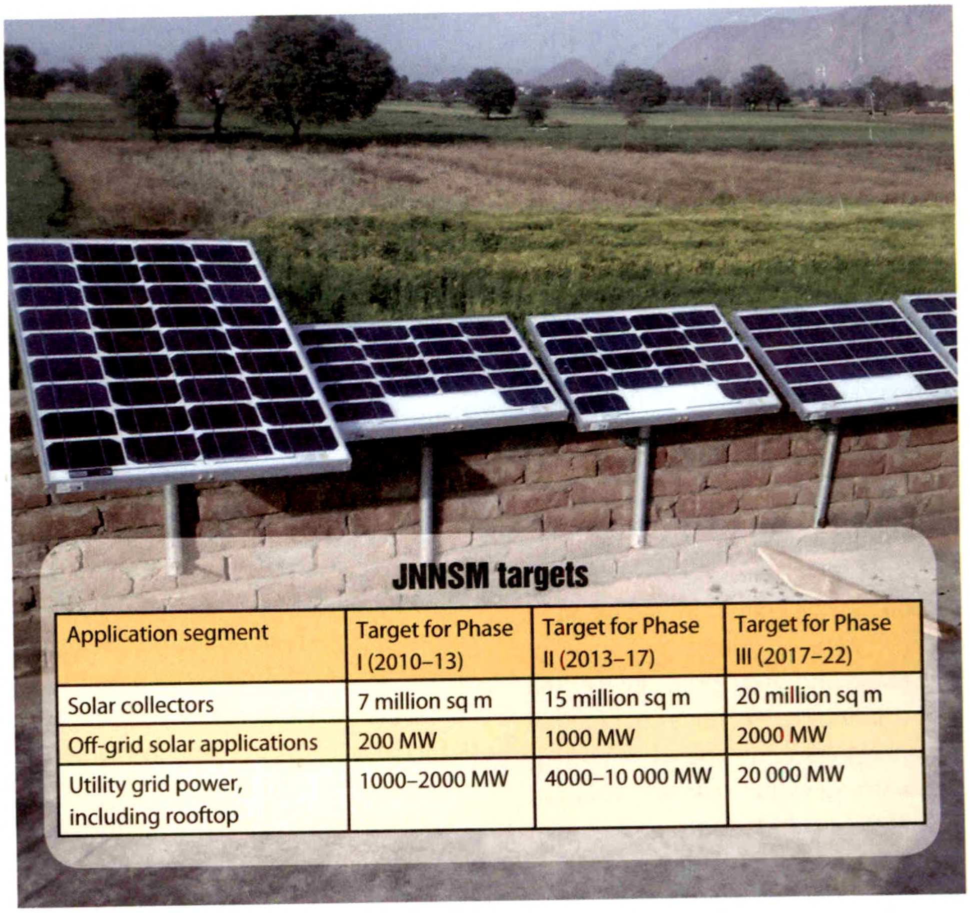
The Solar Mission recommends the implementation in three stages, leading up to an installed capacity of 20 000 MW (megawatt) by the end of the Thirteenth Five-year Plan in 2022. It is envisaged that as a result of rapid scale up as well as technological developments, the price of solar power will attain parity with grid power at the end of the Mission, enabling accelerated and large-scale expansion thereafter. During this time, we expect many new ideas to emerge and technologies to become more efficient. Quite obviously, in order to set the stage for achieving this ambitious target, what we do in the next three to four years will be critical. Therefore, the Cabinet has approved setting up of 1100 MW of grid solar power and 200 MW capacity of off-grid solar applications, utilizing both solar thermal and photovoltaic technologies in the first phase of the Mission. In addition, the Mission will also focus on R&D (research and development) and HRD (human resource development) to develop and strengthen Indian skills and enhance indigenous content to make the Mission sustainable.



The Mission will establish a single window, investor-friendly mechanism, which would reduce risk and at the same time, provide an attractive, predictable, and sufficiently extended tariff for the purchase of solar power for the grid. The focal point for the next three years will be the NVVN (NTPC Vidyut Vyapar Nigam), which is the power trading arm of the NTPC (National Thermal Power Corporation). The government will designate it for the purchase of solar power generated by independent solar power producers at rates fixed by the Central Regulatory Electricity Commission and for a period specified by the latter. The government will provide equivalent MW of power from the unallocated quota of the NTPC for bundling with solar power. The utilities will be able to account for purchase of solar power against their RPOs (renewable purchase obligations).

I wish to record my deep appreciation and thanks to my senior colleague, Shinde Saheb who, as the Minister of Power, has made this arrangement possible and has supported this Mission at every stage of its evolution.

The Mission also includes a major initiative for promoting rooftop solar PV (photovoltaic) applications. Solar tariff announced by the regulators will be applicable for such installations. The



JNNSM targets

Application segment	Target for Phase I (2010–13)	Target for Phase II (2013–17)	Target for Phase III (2017–22)
Solar collectors	7 million sq m	15 million sq m	20 million sq m
Off-grid solar applications	200 MW	1000 MW	2000 MW
Utility grid power, including rooftop	1000–2000 MW	4000–10 000 MW	20 000 MW

power distribution companies will be involved in purchase of this power.

There are several off-grid solar applications, which are already commercially viable or near viability, where rapid scale up is possible. This requires regulatory and incentive measures as well as an awareness campaigns. Solar thermal heating applications, such as water heaters, fall in this category. Solar lighting systems for rural and remote areas are already being distributed commercially in several parts of the country. This is expected to help our rural masses.

The Mission will have a very focused R&D programme, which would seek to address the India-specific challenges in promoting solar energy. We have to pool available resources – both human and financial – to strengthen the existing scientific infrastructure in the country. We would involve various stakeholders in HRD and other capacity building efforts. The Mission will also accelerate the process of development of domestic industry in this sector.

I seek cooperation of members of the House to make Jawaharlal Nehru National Solar Mission a success, which will help establish India as one of the global leaders in Solar Energy.'

It may be noted that the Ministry of New and Renewable Energy has already taken several initiatives on different aspects of the Mission. The ministry has recently cleared proposals to set up 29 MW capacity megawatt-size grid-connected solar power projects under the ongoing demonstration schemes. Recently, 3MW capacity grid solar power plants have been set up in West Bengal and Karnataka. The ministry has also sanctioned several projects to set up about 525kWp (kilowatt power) capacity solar PV projects to save diesel. The ministry is also implementing several other projects for promoting solar thermal energy applications in the country.

The ministry has been interacting with R&D groups, industry, and experts to identify the thrust areas of research. As a result, several R&D projects in solar energy with an outlay of Rs 54 crore are under progress. More projects will be finalized soon. The ministry plans to set up several Centres of Excellence in research in solar energy technologies and strengthening of the Solar Energy Centre under the ministry.

FOR DETAILS ON JNNSM, VISIT THE MNRE WEBSITE <WWW.MNRE.GOV.IN>

US, India sign green energy pact

Barack Obama, President of US (United States), and Dr Manmohan Singh, Prime Minister of India, have agreed to step up cooperation on renewable energy sources and have signed an agreement pledging to speed up development and utilization of clean energy sources.

The renewable energy pact, along with a raft of other agreements, was signed in Washington on the second day of the prime minister's week-long visit to the US. It is seen as a new phase in the partnership between the two countries, which are among the top five carbon dioxide emitters in the world.

A MoU (Memorandum of Understanding) was signed between the two countries to 'enhance cooperation on energy security, energy efficiency, clean energy, and climate change.' This MoU would 'bring together joint ideas on energy efficiency, renewable energy, and green technologies to stimulate the India–US energy dialogue.' Another MoU was signed to intensify cooperation in agriculture and food security, calling for an expansion of the current partnership. Under the umbrella of a new framework called the 'Obama–Singh 21st Century Knowledge Initiative', the two sides have promised to increase university linkages and junior faculty development exchanges between India and the US. The funding for this initiative is to be from both countries.

WWW.RNW.NL

Tihar wants to be world's first green jail

The Tihar jail complex is going green. The authorities plan to use the garbage churned out by the jail's 11 500 inmates each day to produce biogas and electricity, and also tap solar energy across the 400-acre premises. The jail complex wants to produce all the energy it requires through 'green' means in about three years.

The project began recently as collaboration between the Ministry of New and Renewable Energy and the jail administration. B K Gupta, Director-General (prisons), said that under the Rs 96.5 lakh project, electricity-producing biomass gasifier plant(s) would be set up to light the Tihar Jail complex and run its manufacturing units, kitchens, and bakeries within a year. Four eco-friendly biogas plants will be established to run the kitchens as well. Solar panels have already been installed to run water heaters.

'Once the project is completed, we will be meeting almost 40% of our energy requirements on our own,' said Gupta. 'Within the next three years, we expect to meet all our energy needs with the help of the project'. And the energy scheme will save the jail administration Rs 6.6 crore, annually.

Energy-saving measures already in place at the jail include four hours of electricity saving daily and the use of light-emitting diode fixtures and pressurized natural gas ovens. Gupta added, 'The project will make the Tihar Jail complex the world's first green detention centre.'

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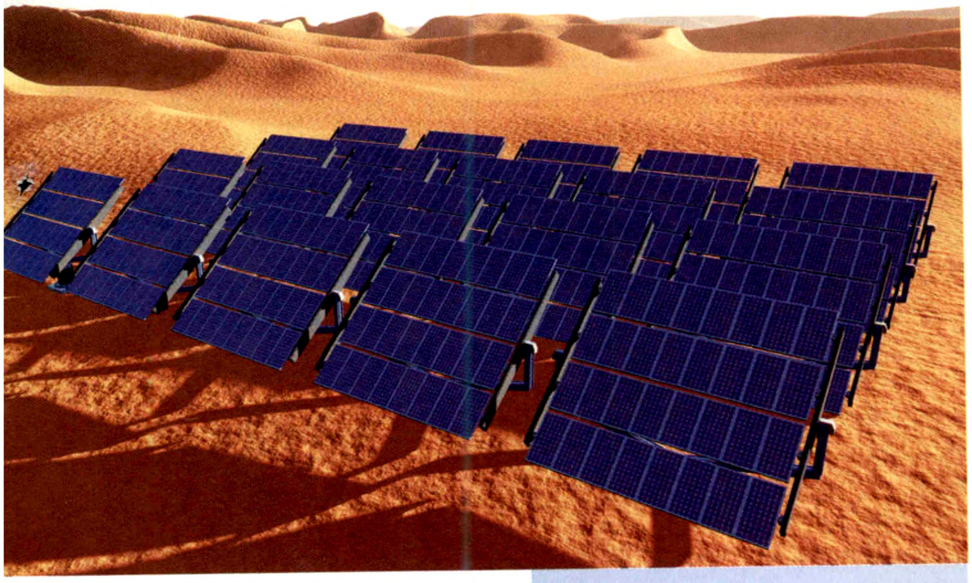
Rajasthan may attract Rs 45k crore in solar power

If things move in the right direction, Rajasthan is set to bask in the sunshine. The desert state is likely to attract an investment of Rs 45 000 crore in the solar energy sector.

Rajasthan Renewable Energy Corporation chairman and managing director Naresh Pal Gangwar told that 72 power companies have registered with the corporation for the generation of 2500 MW in the solar energy sector. ☒We have received proposals from companies like RIL (Reliance Industries Ltd), Par Solar, Jindal Power, GVK Power and Infrastructure Ltd, Moser Baer Photovoltaic Ltd, and Zoom Developers for setting up solar plants in the state. We will take up these projects as per the guidelines of the recently announced Jawaharlal Nehru Solar Mission,☒ he said.



The state government has already sanctioned projects of 66 MW distributed between 11 companies. After the fixing of tariff by the RERC (Rajasthan Energy Regulatory Commission), the companies will start setting up their respective plants across the districts of Barmer, Jaisalmer, Bikaner, and Jodhpur. These plants will be based on different technologies like solar photovoltaic, solar thermal, thin film, and so on.

In addition, RIL and Par Solar are setting up solar plants of 5MW each in Nagaur and Jodhpur, respectively. RIL has already signed up power purchase agreement with three power companies of Rajasthan—Jaipur Discom, Ajmer Discom, and Jodhpur Discom.

However, power generation from solar energy is prohibitively expensive. The cost per megawatt of solar power comes to around Rs 18 crore, while that of wind power is Rs 5 crore and of thermal power is Rs 4 crore.

WWW.ECONOMICTIMES.INDIATIMES.COM

Suzlon signs pact with Australian energy firm

India☒s wind power major, Suzlon Energy, has signed an agreement with Infigen Energy, Australia☒s leading renewable energy company, to provide 20 units of 2.1 MW wind turbine generators, with a capacity to generate 42 MW. The agreement, signed by Suzlon☒s Australian arm Suzlon Energy Australia, is the second order from Infigen, taking the total order to 183 MW.

Currently, Suzlon is executing a 141 MW capital wind farm for Infigen under an EPC (engineering, procurement, and construction) turnkey contract. Infigen has 41 wind farms across Australia, United States, Germany, and France, with an installed capacity of 2246 MW. The wind turbine generators would be installed at one of the wind farms in Infigen☒s pipeline of future projects in New South Wales, Australia.

WWW.HINDUSTANTIMES.COM

Haryana to set up three solar power projects of 225 kw capacity in Gurgaon

The HAREDA (Haryana Renewable Energy Development Agency) has decided to set up three solar power projects of 225 KW (kilowatt) capacity in Gurgaon district under a new scheme launched to motivate commercial/industrial establishments to use solar energy.

Mahender Partap Singh, Renewable Energy and Power Minister of Haryana, said that these project would be set up at a cost of over Rs 5.9 crore. The HAREDA had received sanction from the Ministry of New and Renewable Energy for setting up these projects.

Out of these, two solar power projects of 100 KW each would be set up at M/s Omax Autos Ltd, Manesar, and M/s Automax, Village Binola, at a cost of Rs 2.6 crore each. The third project of 25 KW capacity would be set up at M/s Serco BPO (business process outsourcing) Pvt. Ltd, Gurgaon, at a cost of Rs 88.50 lakh.

The objective of the scheme was to encourage the commercial and industrial establishments, such as malls, hotels, hospitals, and housing complexes, to replace their diesel generator sets installed for their captive requirement during load sheddings with solar photovoltaic power plants, said Mahender Partap Singh.

He said that the initial cost of these systems was high, varying between Rs 2.5 lakh and Rs 3 lakh per KW. Thus, a subsidy at the rate of Rs one lakh per KW or 40% of the project cost, whichever was lowest, was provided to the non-profit institutes and subsidy at the rate of Rs 75 000 per KW or 30% of the project cost, whichever was lowest, was provided to the profit making organizations.

The minister said that interaction meet was organized by the HAREDA at Gurgaon to create awareness of solar energy among the industries, mall owners, builders, hospitals, nursing homes, and other commercial establishments. Due to this initiative, five solar power projects were prepared and sanction for two more such projects is under consideration of the ministry. One project of 30 KW would be set up at Ram Bhagwan Charitable Institute of Cancer at Mirpur, Rewari, and another project of 50 KW at RETREAT, TERI (The Energy and Resources Institute), Village-Gual Pahari, Gurgaon.

WWW.PUNJABNEWSLINE.COM

PE firm invests $49m in renewable energy

United States-based private equity firm, Global Environment Fund, has completed its $49 million investment in the India-based clean energy provider, Greenko. Greenko is one of India's largest independent power producers, which focuses exclusively on renewable energy generation through the construction and operation of hydro and biomass-fired plants. It is understood that Global Environment Fund's investment will accelerate the firm's growth opportunities. 'Consistent with [the fund's] investment strategy, Greenko represents a proven management team that should help meet India's need for sustainable sources of power in the future', said Jeffrey Leonard, President and Chief Executive at Global Environment Fund.

WWW.FINANCIALSTANDARD.COM

Remote village lit up by solar power

A remote village in Karnataka has been illuminated by solar power. The Macchalli Village of Karwar Taluk, Uttara Kannada, finally got electricity supply, with Karwar DC Channappa Gowda inaugurating the solar light facility extended to the village under RGAUY (Rajeev Gandhi Akshaya Urja Yojana) scheme.

Every year, the district administration used to spend lakhs of rupees on the RGAUY function in Karwar. But this time, the deputy commissioner planned to celebrate it in a different way—by utilizing the amount spent on the function to extend the facility of the solar lamps to the houses and streets in the village.

With the cooperation of the Deepa Solar Lighting Systems and the Karwar taluk panchayat, the district administration facilitated all the 14 houses in the village with two bulbs each, while streetlights were installed near the school and temple.

Speaking at the function, the DC said that the celebration of the RGAUY was meaningful because the village, which was deprived of electricity for such a long period after independence, can now enjoy solar power supply. He added that solar power was much more feasible, as it is difficult to lay electricity lines to the remote areas and is economically unviable.

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World Bank funds $500 million for renewable energy and efficiency in South Africa

Funding to the CTF (Clean Technology Fund) Investment Plan in South Africa will allow the country to move towards its goal of 4% of electricity from renewable energy by 2013. The $500 million funding will also allow the country to improve energy efficiency by 12% by 2015 and provide one million homes with solar water heating over the next five years.

The CTF investments in renewable energy and energy efficiency will mobilize financing of $1 billion from bilateral and multilateral funders as well as the private sector. Partners in the CTF Investment Plan include the Government of South Africa, African Development Bank, World Bank, and International Finance Corporation.

The South African Investment Plan is the fifth plan endorsed by the CTF, which is a multi-donor trust fund created in 2009, as part of the Climate Investment Funds (CIF) to provide scaled-up financing for the demonstration, deployment, and transfer of low carbon technologies. CTF resources amount to $5 billion pledged by Australia, France, Germany, Japan, Spain, Sweden, United Kingdom, and the United States.

'Many of our citizens struggle to get access to the most basic of energy services. This plan allows us to help them move directly into a new era of energy access based on the principle of low-carbon growth and development', says South Africa's environment minister, Buyelwa Sonjica. 'In this way, South African citizens can serve as models of a new way of life based on clean energy'.

South Africa's Long Term Mitigation Scenarios have prompted a national climate policy based on lowering greenhouse gas emissions. In response to these scenarios, the government has adopted mitigation strategies that focus on energy efficiency and renewable energy alternatives. As a result of these strategies, South Africa's emissions will peak by 2030 and then decline. Focus will be placed on scaling up grid-connected solar thermal power, utility-scale wind power development, solar water heaters, and demand-side energy efficiency.

WWW.RENEWABLEENERGYFOCUS.COM

Dutch to give $2.9 billion renewable energy subsidies

The Netherlands will make up to €1.95 billion ($2.91 billion) in subsidies available for renewable energy projects in 2010, on top of the €4.5 billion for offshore wind schemes, says the economy ministry.

The government announced new feed-in tariffs for onshore wind, solar, biomass, and hydropower that, according to a ministry spokesman, are expected to boost renewable energy generation capacity by between 554–738 MW (megawatts).

'We are on the right track, but there are still strong challenges ahead of us in the next two years...for us to meet our target of producing 20% of our energy through renewable energy sources by 2020,' wrote Economy Minister Maria van der Hoeven in a letter to the Dutch parliament.

In total, more than 1500 MW of projects are expected to benefit from the subsidies next year, including offshore wind. The Dutch government is holding a special tender for offshore wind projects vying for subsidies.

The government also announced it would offer an €880 million subsidy to build the country's largest windmill farm, an installation near the northern town of Urk, with a capacity of 429MW.

Applications for the 2010 subsidies announced will be accepted from the beginning of January until 1 November 2010.

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UK's biggest data centre to use renewable energy

Being green will be a big deal for some web hosting users and they will be pleased to hear that the UK's (United Kingdom) largest data centre is set to get some of its power from renewable energy. Dumfries and Galloway Council planning officials have now given the go-ahead for the site.

Lockerbie Data Centres will be responsible for construction. The project will cost around £950 million and create 3000 jobs over a 5–10-year period in the region. The facility will cover a 250 000 square metre storage facility.

James Cole, Director of data centre designers Keysource Ltd, said, 'If companies are going to explore data centres efficiently, the data centres should be their first port of call to utilize this.'

He asserted that combined heat and power, localized gas generation and other kinds of technologies can be brought in to use as renewable sources. 'I think careful thought needs to be put on any use of renewable power because if it is going into the data centre and it is unreliable, then maybe that power should be used elsewhere,' commented Cole. There are two key issues that data centre designers face—what they can do with the heat that is created by the facilities and seeing if they can use more renewable sources of power.

Other plans are in place for green data centres to go up across the world. IBM recently announced that it had been chosen by Slovak Telekom to construct a new data centre in Bratislava, Slovakia. The complex will use a cooling system, which will bring in outside air during cold periods of the year, thereby reducing the need to use air conditioning. It will also make use of a high-density layout to make sure that IT equipment is sectioned according to heat emissions so that cooling capacity and efficiency are optimized.

WWW.JUSTHOST.COM

Australia outlines vision for biomass innovation and energy security

The Minister for Resources and Energy, Martin Ferguson, has outlined the Australian government's vision for biomass innovation, describing it as a significant opportunity to address energy security. Addressing the Biomass Energy Investors Workshop in Canberra, Minister Ferguson emphasized the importance of biomass in the energy mix.

'The significance of sourcing energy from biomass is two-fold—to help in the transition to a low-carbon economy and enhance energy security through a broader range of fuels', he said. 'Global targets for reducing carbon emissions demand innovative solutions to energy security, especially solutions which do not deprive people of arable crops or their livelihoods. Biomass-fired electricity and second-generation biofuels are among those innovative solutions.'

Minister Ferguson said the Australian Government was helping to maximize the potential from biofuels through direct funding, tax advantages, and biomass-fired electricity generation through the expanded Renewable Energy Target.

'This year, I announced seven successful applicants under the Second Generation Biofuels Program,' he said. 'This research programme will focus on producing biofuels from algae, sugarcane biomass, mallee, and forest waste', he added.

The Second Generation Biofuels Program has provided $14 million to fund projects examining a range of research, development, and demonstration in biofuel feedstocks and technologies.

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Bangladesh PM's office goes solar to encourage green energy

Sheikh Hasina, the Prime Minister of Bangladesh, has installed a solar power system at her office to encourage 'green' energy expansion in her power-starved nation.

The country's single largest solar power system, with a peaking capacity of generating 21.6 kilowatts, is now operating on a trial basis, said officials of the PDB (Power Development Board), which supervised the installation.

The system has been designed and installed by a local private firm Rahimafrooz Renewable Energy Ltd. The firm mainly produces dry batteries that are exported to India and several other countries.

The move followed a government decision of establishing solar power units in all public and semi-government offices to promote expansion of renewable energy from the sun, wind, biomass, and biogas, aimed at meeting 5% of the country's total power demand by 2015 and 10% by 2020.

At present, contribution of renewable energy to overall power generation is less than 1%, with solar power home systems installed mainly in off-grid areas, which is the current leading green energy generator in the country.

By the end of October this year, more than 400 000 solar power units were installed in different parts of the country generating over 20 megawatts of electricity.

WWW.TRAK.IN

US to invest $620 million in smart grid demonstration

The US DOE (United States Department of Energy) has announced that it is awarding $620 million to 32 projects demonstrating smart grid technologies. The funding from the ARRA (American Recovery and Reinvestment Act) will be supplemented with $1 billion in funds from the private sector.

According to the Electric Power Research Institute, smart grid technologies could reduce the country's use of electricity by 4% by 2030, saving businesses and consumers $20.4 billion.

The demonstration projects will be focused in two areas. The first 16 projects will receive $435 million from the DOE to support smart grid demonstrations in 21 states. These will include real time communication between different parts of the grid; new sensing and control devices to help monitor electricity flow in the grid; and smart meters and in-home systems to allow consumers to control their energy use.

Another 16 projects, which will receive $185 million, comprise utility-scale energy storage projects aimed at improving the efficiency and reliability of the grid. Better energy storage options are needed to support the expansion of variable renewable energy sources like wind or solar.

'These demonstration projects will further our knowledge and understanding of what works best and delivers the best results for the smart grid', says Energy Secretary, Steven Chu. 'This funding will be used to show how smart grid technologies can be applied to whole systems to promote energy savings for consumers, increase energy efficiency, and foster the growth of renewable energy sources like wind and solar power', he added.

WWW.ENERGYEFFICIENCYNEWS.COM

Multilaterals fund Pakistan's renewable energy sector

The European Investment Bank has committed to provide €100 million ($150 million) to Pakistan to partly finance the government plans to develop the country's renewable energy sector. The European Investment Bank is the European Union's long-term financing institution, promoting European objectives through financial assistance to member states and 130 other countries.

Pakistan's renewable energy plan, a multi-year programme to develop the sector to the tune of $2.2 billion, is

being co-financed by the ADB (Asian Development Bank) with $510 million.

The European bank's commitment marks its first reliance agreement with the ADB, which it has tasked to administer loans and to monitor projects it will finance. The European Investment Bank said its collaboration with the ADB will help Pakistan minimize the transaction costs associated with typical loans. This is the European bank's fifth loan to Pakistan, where it started operations in 1993. It is also its third operation with Pakistan's finance ministry.

Carlos da Silva Costa, the European bank's vice president, said that the operation 'is definitely a timely and visible contribution to the European Union policy aimed at consolidating democracy in Pakistan and supporting social and economic development in the country.'

WWW.ECOSEED.ORG

New renewable energy option unveiled

'Green gas' is being offered to UK householders for the first time. Ecotricity, the world's first green electricity organization, is generating the pioneering energy option using a mixture of 'green' and traditional 'brown' sources. Green gas is made using materials that are often dumped in landfill sites, such as food waste, to generate electricity.

According to the company, residents will not have to pay additional costs for the green fuel. It has also pledged to match British Gas' standard gas and dual-fuel charges for each area.

'By choosing green gas, customers can help unhook Britain from its addiction to foreign gas supplies, make a positive long-term change to the world we live in, and could also keep thousands of tonnes of waste out of landfill', said Ecotricity founder Dale Vince.

Currently, Britons throw away more than 18 million tonnes of food a year. However, green gas production could transform this into enough energy to power more than 700 000 homes, every year.

WWW.LOWCARBONECONOMY.COM

Beijing to take measure of renewable energy sector

The Chinese government has started a study of the country's renewable energy industry. Zhou Fengqi, Executive Director of the China Renewable Energy Scale-up Program, was quoted by China Securities Journal as saying that the study aims to accurately determine how the industry is developing.

Zhou said that China's photovoltaic market will follow the same development path as the country's wind power market. For the wind power industry, the government put several wind power projects out for bid in an effort to determine

appropriate power tariffs for future wind projects. Zhou expects that the country's wind power installed capacity may double this year, and he questioned whether it is reasonable for the government to continue to encourage wind power development by handing out such large subsidies to wind farms.

China State Council has also released guidelines that aimed to discourage the development of some parts of the industry, including wind power equipment manufacturing and polysilicon production.

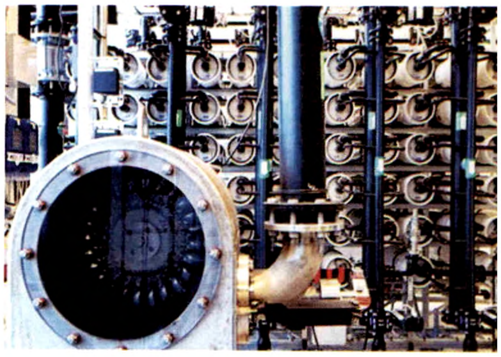
INTERFAX-CHINA

Groundbreaking Norwegian power plant generates electricity from water

New alternative energy plant in Norway is the first of its kind, but could be a common alternative energy in the future. The world's first osmotic power plant has opened in Norway. The plant uses a combination of freshwater, seawater, and a special membrane to generate emission-free electricity. The test plant, which currently only produces enough electricity to power a coffee maker, is a test run of the technology and will be used to develop larger, more efficient versions. The prototype plant, on the Oslo fjord south of Oslo, uses osmosis to draw freshwater across a membrane and toward the seawater side, creating pressure that drives a turbine and produces electricity. The plant has about 2000 sq m (square metre) of membrane.

'While salt might not save the world alone, we believe osmotic power will be an interesting part of the renewable energy mix of the future', said Baard Mikkelsen, Chief Executive of Statkraft, the federally-owned utility company that built and operates the prototype plant. Statkraft plans to begin building commercial osmotic power plants by 2015. Osmotic power can be established anywhere where clean freshwater runs into the sea. Since it is not affected by weather fluctuations like wind or solar energy, it is seen as a more reliable alternative energy source.

The utility hopes to improve the efficiency of the membrane from its current 1 watt per sq m now to about 5 watts, which should make osmotic power costs comparable to those from other renewable sources. Future full-scale plants, producing 25 megawatts of electricity, would be the size of a football stadium with roughly five million sq m of membrane, according to Statkraft.



The utility estimates that osmotic power in Norway will eventually be able to generate 10% of the country's power needs. Europe's total osmotic power potential is estimated at about 5% of the total consumption, which could help the continent reach renewable energy goals that curb emissions of heat-trapping gases and limit global warming.

WWW.CIRCLEOFBLUE.ORG

Inviting advertisements for Akshay Urja

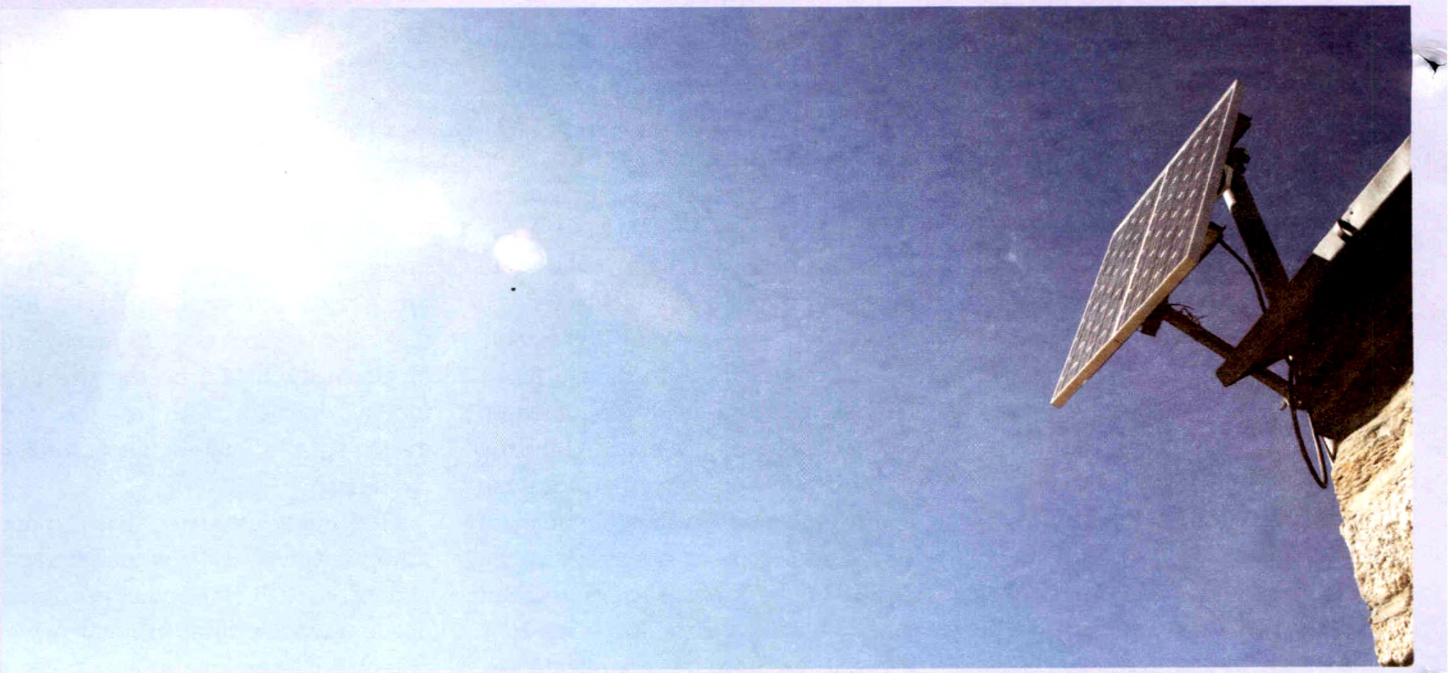
Akshay Urja is widely circulated to various stakeholders of renewable energy. *Akshay Urja* invites advertisements (in colour) from interested organizations, manufacturers, institutions, etc. The advertisement tariffs are as follows.

Advertisement area	Tariff (rupees)*
Inside Front Cover	40 000
Inside Back Cover	40 000
Full Page	25 000

* Avail 25% discount on booking for six issues and 20% discount on booking for three issues

The interested organizations may write to:
Editor, *Akshay Urja*
Ministry of New and Renewable Energy, Block - 14, CGO Complex, Lodhi Road, New Delhi – 110 003
Tel. +91 11 2436 3035 or 2436 0707 • Fax +91 11 2436 3035 or 2436 1298 • E-mail aktripathi@nic.in

INNOVATION PUTS NEXT-GENERATION SOLAR CELLS ON THE HORIZON



In a world first, an international research team led by Monash University, Melbourne, Australia, has developed an innovative way to boost the output of the next generation of solar cells.

Scientists at the Monash University, in collaboration with colleagues from the universities of Wollongong and Ulm in Germany, have produced tandem dye-sensitized solar cells with a three-fold increase in energy conversion efficiency, compared with the previously reported tandem dye-sensitized solar cells.

Although dye-sensitized solar cells have been the focus of research for a number of years because they can be fabricated with relative simplicity and cost-efficiency, their effectiveness has not been on par with high-performance silicon solar cells. Lead researcher Dr Udo Bach of Monash University says that the breakthrough has the potential to increase the energy generation performance of the cells and make them a viable and competitive alternative to traditional silicon solar cells. He adds that the key was the discovery of a new, more efficient type of dye that made the operation of inverse dye-sensitized solar cells much more efficient.

When the research team combined two types of dye-sensitized solar cell – one inverse and the other classic – into a simple stack, they were able to produce for the first time, a tandem solar cell that exceeded the efficiency of its individual components.

The tandem approach – stacking many solar cells together – has been successfully used in conventional photovoltaic devices to maximize energy generation. But there have been obstacles in doing this with dye-sensitized cells because there has not been a method for creating an inverse system that would allow dye molecules to efficiently pass on positive charges to a semiconductor when illuminated with light,' says Dr Bach. 'Inverse dye-sensitized solar cells are the key to producing dye-sensitized tandem solar cells, but the challenge has been to find a way to make them perform more effectively. By creating a way of making inverse dye-sensitized solar cells operate very efficiently, we have opened the way for dye-sensitized tandem solar cells to become a commercial reality.'

Dr Bach says that the breakthrough, which is detailed in a paper published in Nature Materials, is an important milestone in the ongoing development of viable and efficient solar cell technology. 'While this new tandem technology is still in its early infancy, it represents an important first step towards the development of the next generation of solar cells that can be produced at low cost and with energy-efficient production methods,' he feels.

With this innovation we are one step closer to the creation of a cost-efficient and carbon-neutral energy source.

WWW.MONASH.EDU.AU

BIOMASS GASIFIER-BASED DISTRIBUTED/OFF-GRID PROGRAMME

FOR RURAL AREAS AND GRID POWER PROGRAMME

Biomass gasification is deemed as one of the best ways to power rural households across the world. It is basically the conversion of solid biomass (wood, agriculture residues, and so on) into a combustible gas mixture known as Producer Gas.

In India, small-scale biomass gasifiers have been installed in various states. And the MNRE (Ministry of New and Renewable Energy) has been implementing a wide range of national-level programmes for encouraging the use of this technology in the country. Here are the main highlights of the 'Biomass gasifier-based distributed/off-grid power programme for rural areas and grid power programme' under implementation by the MNRE.

Programme components

i. Biomass gasifier-based distributed/off-grid power programme for rural areas: Biomass gasifier-based distributed/off-grid power systems in rural areas limited to 250 kW installed capacity, which have surplus biomass resources and unmet demand of electricity for interalia lighting, water pumping, and microenterprises, including telecom towers, will be supported. The project may preferably be set up following a cluster approach.

ii. Biomass gasifier-based captive power generation in rice mills: Biomass gasifier-based captive power plants will be supported in rice mills for meeting their captive needs and surplus power fed into the grid or distributed in local areas.

iii. Biomass gasifier-based grid-connected power programme:
   a. Biomass gasifier-based MW (megawatt) level grid-connected power plants with 100% producer gas engines will be supported.
   b. Biomass based grid-connected BTG (boiler-turbine-generator) projects, preferably at tail end of the grid and with a decentralized distribution component, would also be supported.
   c. The maximum installed capacity of each such project would be 2 MW.

iv. Promotional activities: Support to activities such as awareness creation, publicity measures, and seminars/workshops/business meets/training programme; to expand local manufacturing capacity; and to support service facilities under the programme.

Implementation strategy

Programme Implementing Agencies/Organizations

Project proposals as per guidelines could be submitted online/directly to the MNRE by the SNAs (State Nodal agencies)/departments, ESCOs (Energy Service Companies), Cooperatives, Panchayats, SHGs (self-help groups), NGOs (non-governmental organizations), manufacturers or entrepreneurs, independent power producers, promoters and developers, and so on.

Submission and approval process

The following methodology would be followed for submission and approval of project proposals.

i. Programme Implementing Agencies/Organizations will submit proposals to the MNRE with requisite information, separately for village-based proposals through gasifiers and gasifier-based captive power project in rice mills using husk.

ii. Grid-connected project proposals should contain DPRs (Detailed Project Reports). The project developer should enter into agreement with the utilities for sale of power or third party sale, and furnish all requisite documents. Only grid-interactive projects which have envisaged fuel linkage mechanisms to ensure regular supply of the required quantity of biomass feedstock and provision of collection, processing, and storage of biomass would be supported. The projects based on BTG route should have provision for decentralized distribution component and details should be provided in the project proposal.

iii. A PAC (Project Advisory Committee) set up by the MNRE would evaluate and recommend the proposals for issue of in-principle approval based on the programme guidelines, project details, and commissioning schedule. PAC would consider in-principle approval for the projects cumulatively costing up to 125% of the approved budgetary allocation for the given year.

Pattern of Central Financial Assistance

Pattern of CFA (Central Financial Assistance) for various components is given below.

Items	Pattern of CFA
Distributed/off-grid power projects in rural areas and grid-connected power projects with 100% producer gas engines or biomass-based combustion projects.	Rs 15 000 per kW
Biomass gasifier systems retrofitted with dual fuel mode engines	Rs 2500 per kW
Captive power projects (captive power less than 50%) and/or feeding surplus power to grid in rice mills (with 100% producer gas engines or biomass-based combustion projects).	Rs 10 000 per kW
Projects involving installation of 100% gas engines with an existing gasifier.	Rs 10 lakh per 100 kW
Biomass gasifier projects for distributed/off-grid for rural areas and grid-connected power projects for ensuring regular availability of biomass, provision of collection, processing and storage, and operation and maintenance, including compulsory AMC (annual maintenance contract) for 5 years after the guarantee period.	Rs 1.5 lakh per 50 kW
Support towards lighting devices and distribution network	Financial support limited to a maximum of 3 km, that is, Rs 3 lakh per project (@Rs 1 lakh per km).
Support towards project formulation	Financial incentives of Rs 5000 per project to the banks/FIs (financial institutions), manufacturers, promoters, consultants, and service providers for developing firmed up and bankable proposals for a minimum of 10 projects or above.
Service charges for verification and certification	Rs 10 000 per 100 kW subject to maximum of Rs 1 lakh for a project of 1 MW capacity. A minimum service charge would be Rs 10 000 per site.
Preparation of DPRs for centralized distributed/grid-connected/captive power generation project: • Projects between 100–500 kW capacities. • Projects above 500 kW capacities. • DPR is not required for the projects below 100 kW capacities.	Rs 0.5 lakh Rs 1 lakh
HRD (human resource development) and training • O&M (operation and management) Technician's Course • Gasifier Entrepreneur Development Course • Awareness promotions, such as organization of seminars, business meets, workshops, and so on.	- @Rs 2 lakh per course - @Rs 3 lakh per course - Maximum up to Rs 3 lakh
Support for gasifier manufacturers/suppliers for establishing service centers in areas where cluster of systems – minimum 10 – have been set up in one district/region.	Rs 5 lakh (one-time funding)
Special category states and islands	20% higher CFA

- Verification and commissioning reports along with Joint Commissioning Report.
- Statement of expenditure duly audited by a chartered accountant or other designated authority as per the Government of India rules.
- The Utilization Certificates in the prescribed format as per the GFR Form-19A to be submitted after the receipt of funds.
- Verifying agency certificate ensuring that the agreement between the user and supplier of the gasifier systems for full guarantee and warrantee for one year, followed by AMC for two years, has been entered into.

Pattern of release of funds

i. CFA, as applicable under the scheme, will be disbursed post-commissioning through one installment directly to the promoters or lending institutions/FIs, after receipt of commissioning and verification reports and submission of the requisite documents/reports.

ii. The service charges for IVA (Independent Verification Agency) or SNAs, as the case may be, would be provided after commissioning and certification by the designated agencies as per the guidelines. The service charges would be provided to the designated agencies, including the SNAs and FIs, including banks, to cover their expenses.

iii. Programmes related to Training and Awareness Promotion: 75% of the eligible CFA will be released to implementing organizations along with the sanction order. The balance will be released on receipt of the utilization certificate, audited statement of expenditure, and the final report.

Independent verification system

1. The MNRE will separately empanel IVAs other than the SNAs.
2. Verification would be conducted after the operation of project at least for a period of one month.
3. The IVAs would be required to furnish the following requisite documents/reports:

HRD and training

O&M Technician's Course

Financial support would be provided for organizing training programmes to train gasifier operators at selected engineering colleges/polytechnics in the identified cluster, involving programme implementation organizations and gasifier and engine

manufacturers. The training would be for eight weeks, involving limited classroom exercises with hands-on training. Each training programme will have a minimum of 10 candidates. The tentative schedule for such training course is suggested below.

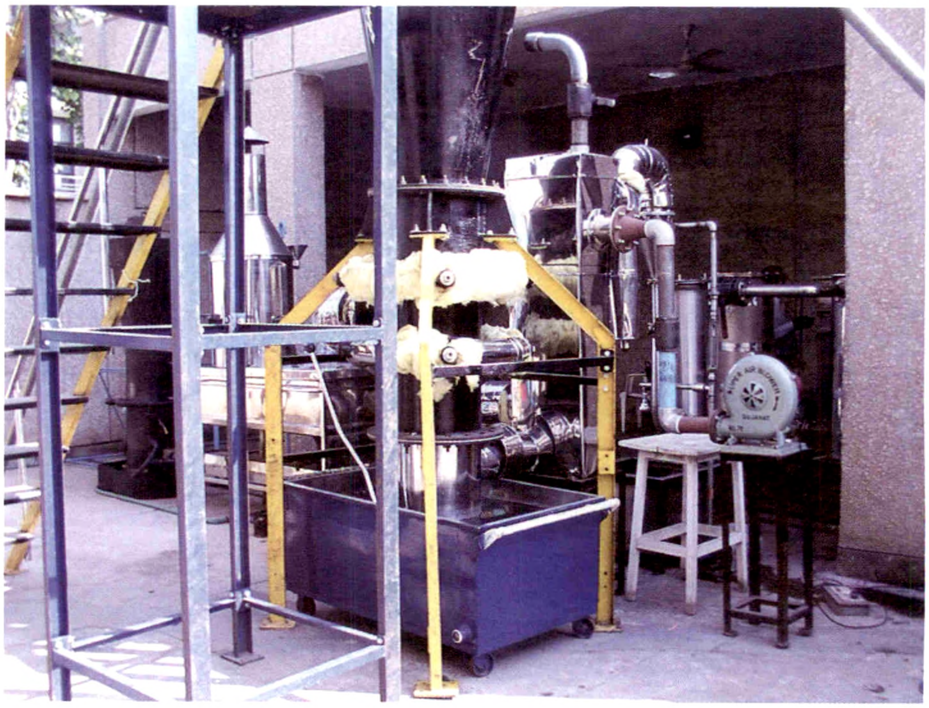
- Training at institute: 4 weeks
- Visit to biomass gasifier and engine manufacturer: 2 weeks
- Field visits: 2 weeks

Under these training programmes, stipend @Rs 5000 per month (total Rs 10 000) would be paid to the trainees for the entire 8 week duration. In addition, financial support for institutional charges, field visits, materials, tools (including contingencies), and so on would be provided @Rs 2 lakh per course.

Gasifier Entrepreneur Development Course

Financial assistance will be provided for organizing EDPs (Entrepreneurship Development Programmes). Such EDPs would be provided for about 3 months for 15 persons per batch. Financial assistance would include institutional faculty charges and training expenses (field visit, classroom training, manuals and other materials, contingencies, and so on). Such course would be supported @Rs 3 lakh per course, as per the existing provisions of the scheme.

Single or multiple courses would be organized in association with engineering colleges/polytechnics, gasifier manufacturers, programme implementing organizations, and so on.



Technology Demonstration Component

For technological demonstration, the existing level of subsidy will be provided for the gasifier with 100% producer gas engines components. In addition, financial assistance of up to 50% of the cost of plant and machineries – VAM (Vapour Absorption Machine) for cooling/chilling system and steam generating system from waste heat – would be provided. Financial assistance would not be provided for land and building.

It is proposed to take up about 25 demonstration projects in rice mills, replacing steam engines/boilers with biomass gasifier coupled with 100% producer gas engines for power generation, along with provision for meeting the entire thermal requirement through waste heat recovery. Under some of these projects, demonstration of cold storage or ice-making units would also be taken up using waste heat for chilling/cold storage through VAM and steam generating systems.

The projects would be taken up as per RD&D (Research, Design, Development, and Demonstration) policy of the MNRE for technology demonstration on a 50:50 cost sharing basis. The proposals will be examined by a committee set up in the MNRE for the purpose. The selected projects will be placed before TDPAC (Technology Demonstration Project Appraisal Committee), as provided under the RD&D Policy of the MNRE.

For more information, visit <www.mnre.gov.in>

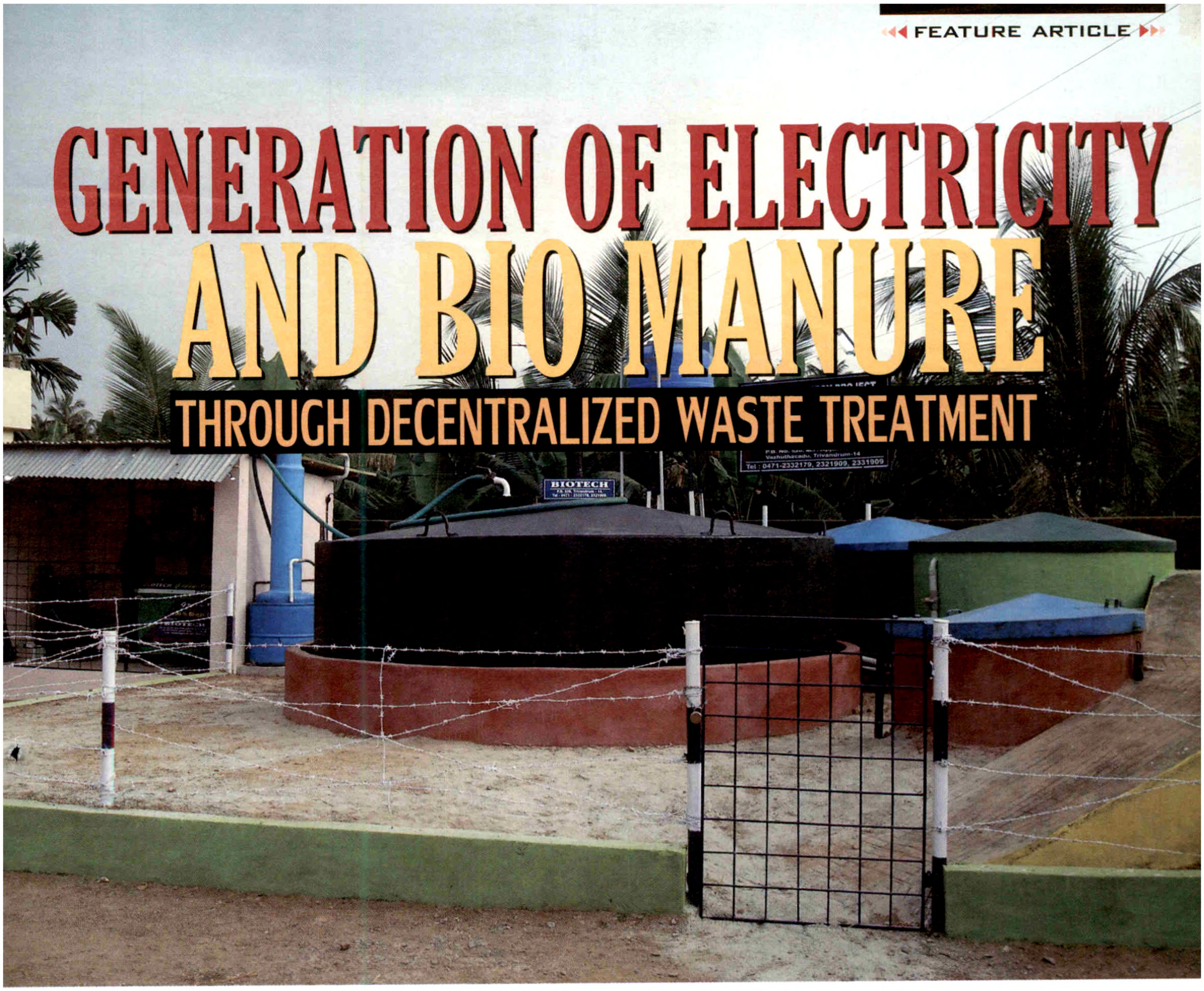
Courtesy: MNRE

Did You Know?

- The photovoltaic cell was discovered in 1954 by Bell Telephone researchers examining the sensitivity of a properly prepared silicon wafer to sunlight.
- The world's largest wind farm, the Horse Hollow Wind Energy Center in Texas, has 421 wind turbines that generate enough electricity to power 2,20,000 homes per year

GENERATION OF ELECTRICITY AND BIO MANURE

THROUGH DECENTRALIZED WASTE TREATMENT



A SAJI DAS, DIRECTOR, BIOTECH, THIRUVANANTHAPURAM, KERALA

In accordance with the fast-growing population, the demand for energy and the discharge of waste are increasing day by day. The only remedy to the energy crisis is the use of alternative energy sources. And one of the best alternative ways is the generation of energy from waste, which is beneficial in several ways. It is most suitable for eco-friendly waste disposal and also for energy generation.

To find out a permanent solution to the problem of contagious diseases caused by the accumulation of waste, it is quite necessary that we extend the scheme of implementation of decentralized waste treatment programmes all over the country. Biogas technology enables us to produce bioenergy in households by treating the waste generated. This technology is also applicable to treating the waste produced from public places like markets, slaughter houses, hotels, and so on and for generating electricity without causing any pollution to the atmosphere.

Technology adoption for fast degradable materials

Through the utilization of biogas technology (Biomethanization) for decentralized waste management, the collection, transportation, and segregation of waste can be totally avoided as the wastes are treated at the source itself.

Biomethanization technology

Biomethanization is a universally accepted and proven technology for bioenergy generation from bio waste.

It is very simple, user-friendly, and needs no recurring expenses. Through the adoption of biomethanization technology, all degradable waste can be treated with the help of different types of anaerobic bacteria/microbes in a concealed chamber/digester. The treated biomaterials that come out of the digester in liquid or semi-liquid form can be used as a very good bio manure/organic fertilizer.

Generation of electricity from biogas

The main advantage of the waste-to-electricity project is that no external power is required for the operation of the plant. The power generated in the treatment plant can be utilized to meet the in-house requirement completely. Excess quantity can be utilized for any type of application, including street lighting, providing lights to the markets, and the likes.

Generally, 1.5 KW (kilowatt) of electricity can be produced from one cubic metre of biogas. Depending upon the percentage of methane content in biogas, the power generation may vary slightly. The size of the generator can be fixed depending upon the availability and the quantity of gas and the duration for the requirement of power. The gas can be utilized as the operation fuel in generators. Before feeding biogas as the fuel in generator, the gas has to be passed through a gas scrubber to remove unwanted particles, gases, moisture, and so on.

Two types of generators are used for generating electricity from biogas. One is the dual fuel model and the other is the 100% biogas model. Dual fuel models are basically diesel generator sets. In this system, the biogas is connected to the generator through air mix. Once the biogas is passed through the generator, the consumption requirement of the diesel is automatically reduced. Usually, dual fuel generators work in 80%–20% mode.

In the 100% biogas engines, no other fuel is required either for starting or for operating them. Any type of petrol engine can be modified for operating the same, using biogas as the operation fuel. The imported models of 100% biogas engines are very costly and the maintenance of such systems is also very expensive. BIOTECH, a Kerala-based non-governmental organization, has developed 100% biogas engines, which have been installed in various projects. And the performance of all of them has been very good.

Operation of waste-to-electricity plant

The biowaste generated in fish and vegetable markets, slaughter houses, and so on are collected in separate bins,

BIOTECH

BIOTECH–Kerala is a registered non-governmental organization that started functioning from 1994. The main activities of BIOTECH, from its very inception, include promotion, implementation, training, research and development, and creation of awareness among the people in the field of creation of renewable energy by waste management.

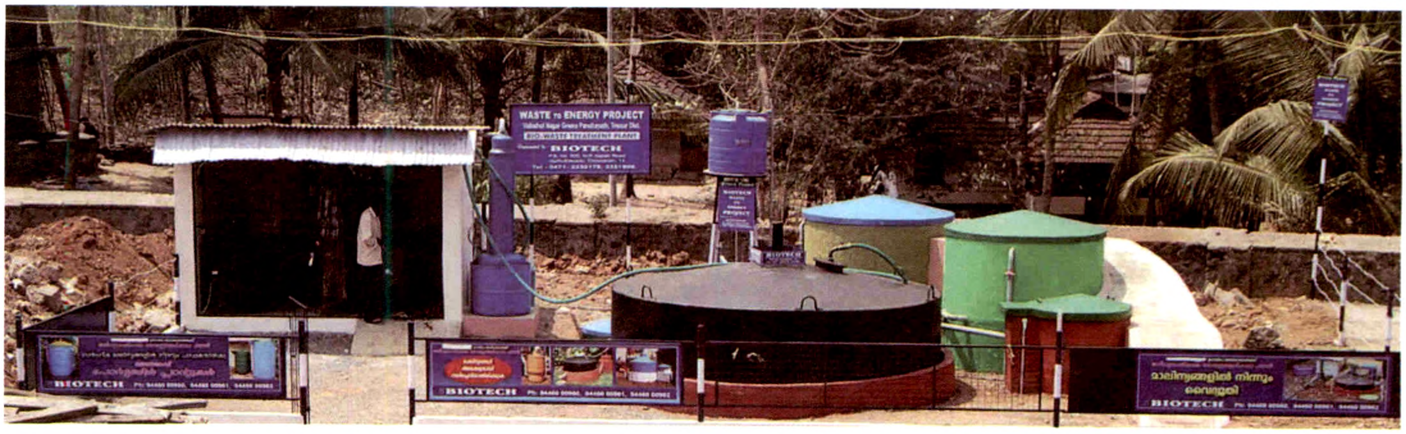
Different models of plants for the treatment of waste, according to the requirement of the consumers and the nature of waste, have been developed by BIOTECH. These models cater to the needs of different categories of beneficiaries, such as domestic households, public institutions like hospitals, schools, hostels, and convents, and local body establishments like Panchayats, municipalities, corporations, and the likes, for treating different types of waste. BIOTECH has successfully installed around 15 000 family-size plants with the financial assistance from the MNRE (Ministry of New and Renewable Energy), Government of India, and with the active cooperation of the local bodies.

BIOTECH also renders consultancy services for the preparation of projects, conducts feasibility studies, and undertakes project implementation. In recognition of its selfless services to the society, BIOTECH was conferred the prestigious International Ashden Award—GREEN OSCAR 2007.

which are carried to the treatment plant site. After final sorting, easily degradable biowaste is allowed to pass into the digester/reactor. Slow degradable materials are fed into the pre-digester and the treated slurry is mixed with this feed material every day. The leachate from the pre-digesters is extracted through specially designed filters and channelized to the digesters for biogas production. The organic waste thus fed into the plant decomposes within days through anaerobic process and the methane gas generated is collected in the gas holder of the plant. For the effective operation and long life of the generators, the gas generated has to be purified before utilization. For eliminating H2S (hydrogen sulphide), unwanted dust, and moisture content, this gas is allowed to pass through filters and gas scrubbers developed by BIOTECH. After filtration, it is channelized to the generator for electricity generation. Electricity thus generated from the plant is utilized to meet the in-house requirement and for street lighting. The treated biowaste can be collected from the pre-digesters, which can be utilized as biomanure.

Biomanure

The treated biowaste material from the digester is in liquid or semi-liquid form. This is a very good fertilizer for all types of plants. This can be mixed with equal or more quantity of water and directly applied to plants. The solid manure from this slurry can be separated through the filtering process. Filtered liquid can be utilized and the solid fertilizer can be kept for later use. The treated solid biomanure can also be collected directly from the pre-digester developed by BIOTECH. The biomanure generated by the treatment of biowaste is a better substitute of chemical fertilizer. Through its utilization, the huge amount of money spent for purchasing chemical fertilizers can be saved to a great extent. The growth ratio of plants would also highly improve within a short period of time. In addition, the resistance power of plants from insects will be improved. In short, the treated slurry can be called a tonic for plants. And this is not all. The water storage capacity of the soil will also be improved through the application of solid biomanure. The presence of insects in the soil can also be avoided to an extent.



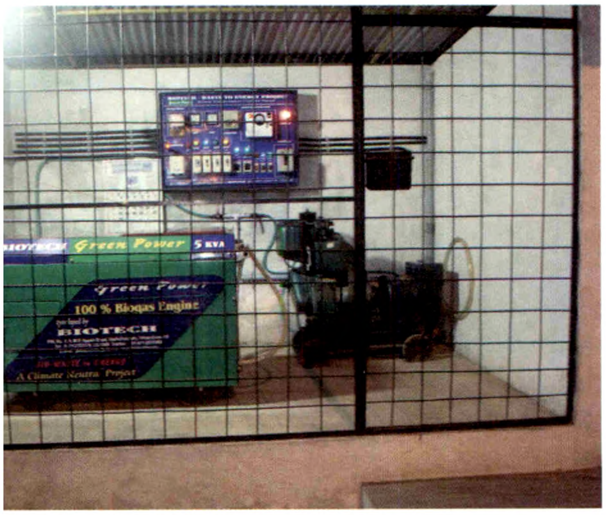
Types of wastes that can be treated under Biomethanization Technology

All easily degradable materials, including cooked and raw food wastes; fruits and vegetable waste; fish and meat waste; excreta of all domestic and wild animals and birds; and wastewater containing biowaste materials can be treated with this technology. Slow degradable materials like vegetables and green or wet plant parts can also be treated with this technology, using specially designed pre-digesters.

Green Power
BIOTECH
WASTE TO ENERGY PROJECT
Implemented by
BIOTECH
P.B. No. 520, M.P. Appan Road,
Vazhuthacadu, Trivandrum-14
Tel : 0471-2332179, 2321909, 3950012

The main parts of a waste-to-electricity plant

Digester, gas collector, anaerobic pre-digester, slurry loop system, 100% biogas generator, standby generator, biogas scrubber, dehumidifier, control panel, power distribution system, and Exes Gas reservoir.



History of waste-to-electricity projects in Kerala

Kerala's first biowaste treatment power generation plant was installed eight years ago at Pathanapuragm Gram Panchayat in the Kollam District. This plant treats 250 kg of organic waste and generates 3 KW of electric power every day. After the successful completion of this project, 42 Gram Panchayats in Kerala came forward for the installation of such plants. BIOTECH has completed the installation of the power generation projects using market/slaughter house waste with power generation capacities ranging between 3 KW and 10 KW. The power generated from these projects is being utilized to meet the energy requirements of the concerned markets and the in-house requirement of the plant.

Specialty of BIOTECH waste-to-electricity projects

1. There is no need of using grid electricity for the regular operation of the plant. A part of the power generated from the plant is utilized to meet its in-house requirement.
2. There are less moving parts or complicated machineries.
3. The introduction of anaerobic pre-digesters helps to treat the waste completely and to collect the treated waste. It checks scum formation in the plant. The inbuilt slurry loop systems accelerate the fermentation process and reduce the consumption of water. A part of the treated slurry is also sold as liquid organic fertilizer.

If similar decentralized waste treatment plants are installed all over country, it would be very helpful for the production of biogas, electricity, and biomanure, apart from the treatment and disposal of unwanted waste. We wish that similar projects may be implemented all over the country with the cooperation and support of all concerned.

For more information about waste-to-electricity projects, contact:

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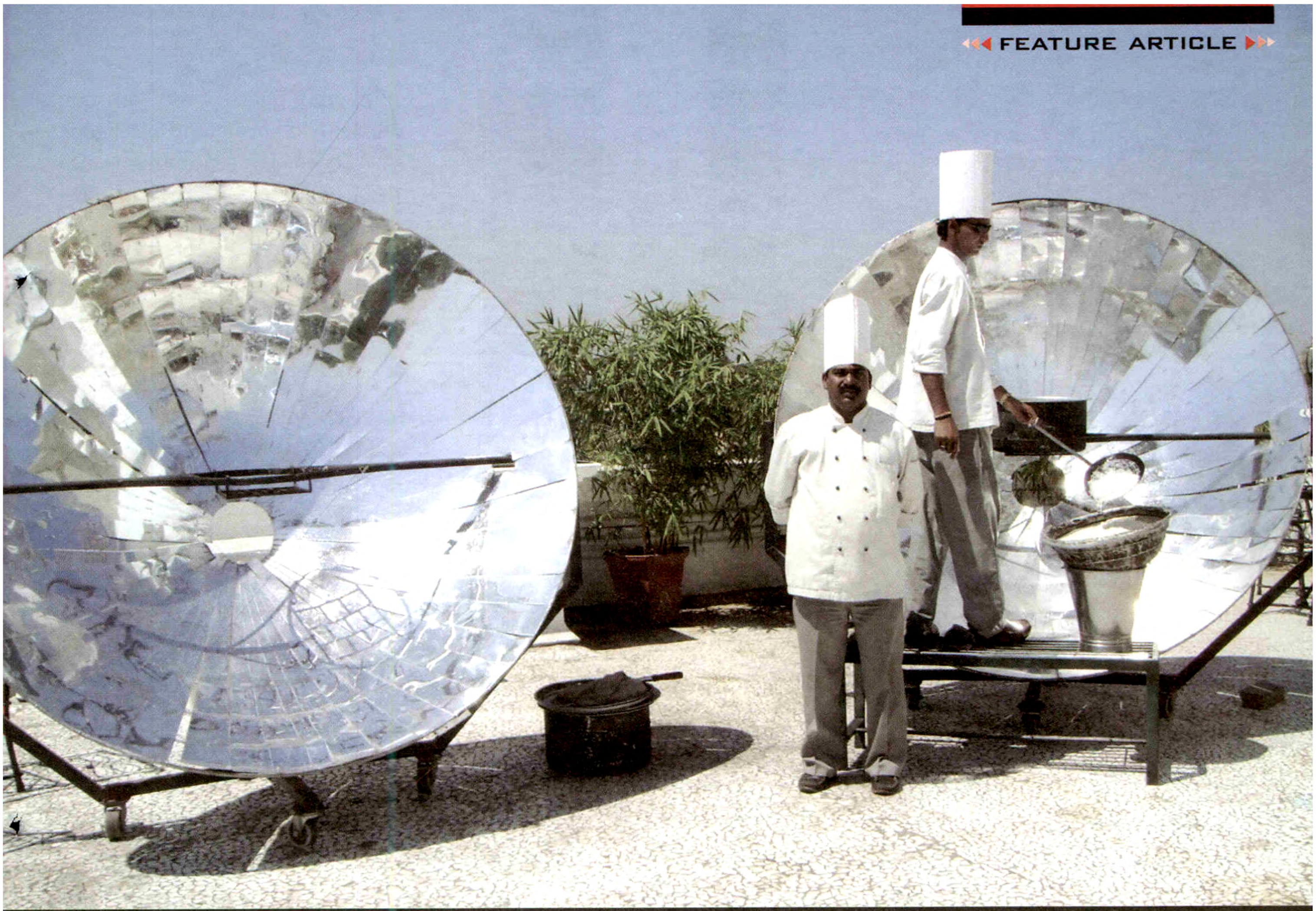

PROF. AJAY CHANDAK[1], DR SUNIL K SOMANI[2], AND RAHUL KULKARNI[3]

DEVELOPMENT OF SOLAR COMMUNITY DISH COOKERS

Based on very encouraging experiences with SK-14 cookers, Prof. Ajay Chandak designed solar community cookers of 2.0 m and 2.3 m diametres. After removing few teething problems, a number of agencies were trained to manufacture these community solar cookers. Because of the huge cost advantage and simplicity in operation, these community cookers are gaining popularity in the private sector as well as in other organizations. There was a big breakthrough when Rahul Kulkarni bagged an order from the Government of Maharashtra for 300 community solar dish cookers for tribal schools. This might be the single largest solar cooking project in the world, which was executed in the record time

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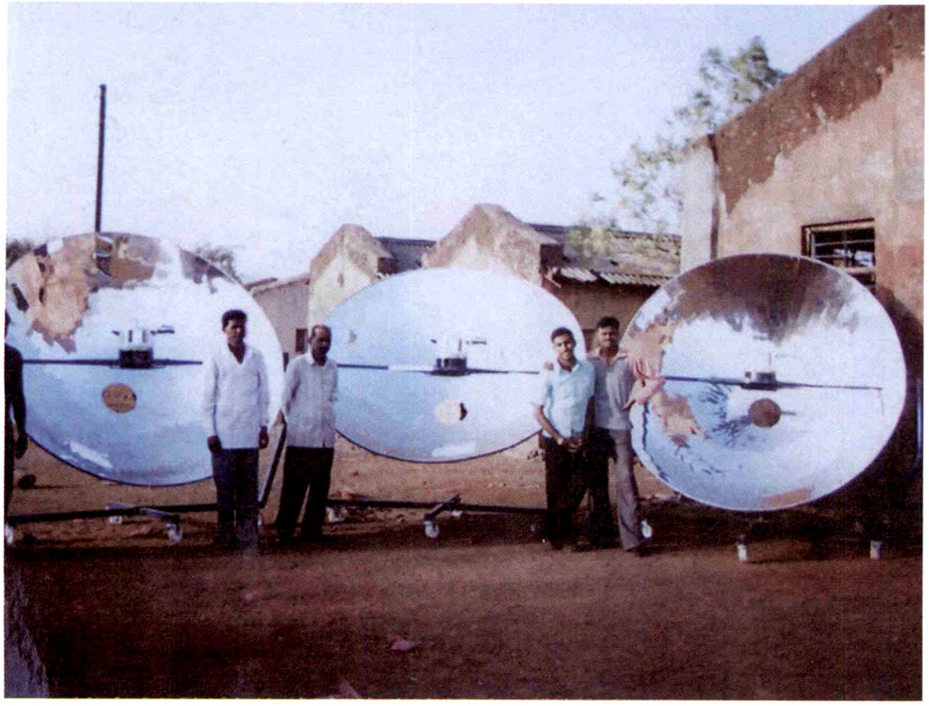


of 45 days. Recently, new square- and rectangular-shaped community dish cookers, PRINCE-30 and PRINCE-40, have also been developed.

Introduction

Even though cooking with solar concentrators is slowly picking up in India, there are very few community cooking systems. Most of the existing systems are based on the 'Scheffler concentrators'. This is one of the best possible options available for community cooking, but still, it is not practiced on a large scale by common people and organizations. The promotion of this technology largely depends on the subsidies. Because of financial constraints and operation and maintenance issues, the technology is not widely adopted by the private sector and the small organizations.

An effort was made by Prof. Ajay Chandak to design simple parabolic dish cookers – SK-20 and SK-23 – of 2.0 m and 2.3 m diametres respectively, on the similar lines of SK-14. The effort was fairly successful. This article gives details about the development efforts and the success stories related to this simple product.

Background

After participating in an eight-day workshop with Wolfgang Scheffler, Prof. Ajay Chandak and Rahul Kulkarni were fascinated with his engineering innovation. The idea of cooking indoors was amazing. After coming back from the workshop, Rahul Kulkarni manufactured one Scheffler concentrator, which was working well. Prof. Ajay Chandak got two Scheffler systems installed at his personal energy park. With enthusiasm, these systems were demonstrated to many people and organizations, but somehow, Rahul Kulkarni could not sell a single system in the first year. Few enquiries were generated but none of them materialized. After discussion with the prospective clients, the following hurdles were noticed in the promotion of Scheffler technology.

a. High capital investment: Scheffler concentrators typically cost Rs 100 000 for a concentrator of 10 sq m. Many customers feel that this price is quite high. The existing kitchens do not suit the installation of Scheffler concentrators in most of the cases, and additional investment in a new kitchen retracts many probable customers.
b. Product manufacturing is difficult and there are very few competent suppliers in the market.
c. The system is a permanent installation. The tracking mechanism still has some teething problems.
d. Area around the reflector needs to be always shadow-free, which may not be practicable in few cases.
e. Operation and maintenance require some skill.

In the meantime, Rahul Kulkarni started manufacturing SK-14 cookers, which were receiving very good response. Hence, it was decided to manufacture a new community cooker, which is as simple as a SK-14, but will fit in the budget and other expectations of the clients. Two different models were designed with 2.0 m and 2.3 m diametres. Both the cookers were giving excellent field performance. These cookers were tested at the Regional Test Centre in Pune. And few successful installations and very promising test report from the Pune University helped in selling more and more systems.

SK-23 community parabolic cooker of 2.3 m diametre

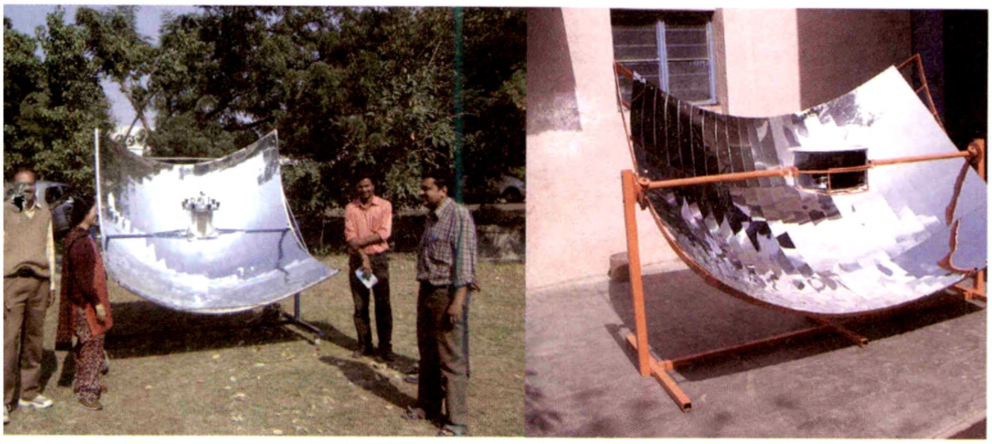
Because of the low capital investment, it was possible for the authors to convince few clients to adopt these new systems. Matoshri Vridhashram was the first client. Few teething problems were noticed and rectified in the new designs. Here are the common problems observed in them and their solutions.

a. The wheels for the cookers needed to be very strong. So, industrial grade wheels used for trolleys were provided.

b. Some correction in the parabolic shape was required to balance the weight of the dish. The design was rectified with lower focal distance.

c. The cooking place was too high for the cook for placing heavy cooking vessels. Small fabricated platform with a stair was provided.

d. A hole of around 400 mm was kept at the centre of the cooker as an escape route for wind. This was working well even in high wind conditions.



The installation at Matoshri Vridhashram is in operation from the last six years and is a demonstration site for all prospective customers. Following are the salient features of SK-23.

i. Easy manufacturability: Simple workshop set up with welding and drilling machine is required.

ii. Very simple in operation and maintenance.

iii. Manual tracking: Tracking is required every 20 minutes.

iv. Concentrator is mounted on industrial grade heavy-duty wheels. These can be used for tracking and also, for shifting the system from one place to other. This is because at few sites, the Sun is available at different locations in the morning and evening.

v. Intellectual property rights are with Prof. Ajay Chandak.

vi. Installation is easy and can be done within a day. Many installations in a short duration are possible.

vii. These systems enjoy big cost advantage over other community solar systems. Cost per sq m of aperture area is about Rs 6000, as against the Rs 15 000 for most other concentrators.

viii. Major limitations as compared to Scheffler concentrators are manual tracking every 20 minutes and one has to work in the Sun.

Few installations were made for commercial organizations like R M Chemicals in Dhule, Hotel Emerald Park at Nasik, and so on. The savings reported at these locations were up to half a cylinder (around seven kg) of LPG per day. The repeat orders received from these commercial clients are a good indicator of the success of the systems. It is important to note that all these systems were installed without subsidies.

Product promotion strategies

There is a mid-day meal scheme in operation in all primary schools and *Aanganwadis* in India. These schools serve *khichadi* in Maharashtra. It was noticed that 3 kg of *khichadi* by dry weight (2.5 kg of rice and 0.5 kg of pulse) is served for 50 students, with 60 gm per student as a standard norm. Considering the large number of such schools in the state, it was decided to tap these schools as prospective clients. The authors focused on the tribal residential schools where access to fossil fuels is difficult and firewood is the main fuel. The Regional Test Centre at the Pune University was requested to carry out field cooking test with 3 kg of *khichadi* and add the result of this cooking test to the technical report. This proved to be the turning point. These test results helped to convince the tribal minister and his officers to adopt these cookers.

Apart from cooking, an effort was made to locate new applications. Uses of these concentrators for preparation of Ayurvedic medicines and for autoclaving by doctors were few other successful applications.

Tests and results

Different tests were performed on the cookers at the Regional Test Centre at Pune University and many trials were conducted in-house. Special cooking test was recommended for 3 kg of *khichadi*. First trials were conducted in March 2005 by one of the manufacturers M/s Rajkamal Enterprises. Another manufacturer M/s Essential Equipments got the trials done in January 2007. Test results of both the manufacturers are compiled together, and are presented herewith.

Performance tests

Performance tests reveal the most important information regarding cooking capabilities. Thus, performance tests were carried out for establishing field cooking test (*Table 1*).

Stagnation temperature test

In 3-litre-capacity frying pans, 1000 ml and 1500 ml of oil were placed. Readings were recorded every minute (*Table 2*).

Thermal Performance Test

In March 2005 and January 2007, 8000 ml and 6000 ml of water was used for tests, respectively.

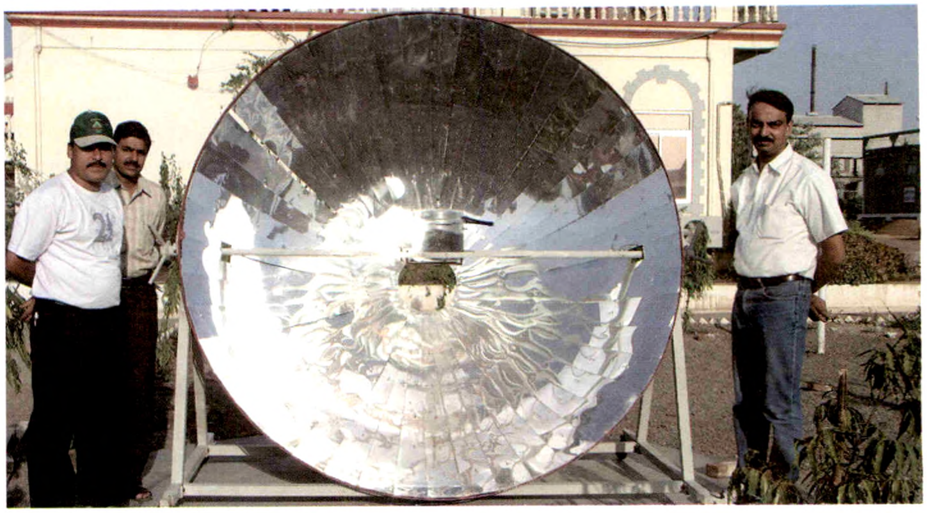
The overall thermal efficiency was recorded at 37% and 36%, respectively. Considering the reflectivity of sheets at 80%, overall thermal efficiency of 36% can be treated as good. Thermal efficiency is higher at lower temperatures and goes on reducing as operating temperatures goes on increasing.

All tests and trials on the cooker carried out in-house are in the close range of the test results obtained from University of Pune.

Adoption of technology by tribal ministry in Maharashtra

With test certificates from authentic test centers and field performance reported from the users, the state nodal agency of Maharashtra, MEDA (Maharashtra Energy Development Agency), published the success story of this new product in their news bulletin. It was possible to motivate tribal ministry authorities on this background to adopt this technology. MEDA proposed the utilization of this technology for residential tribal schools and a trial order for 60 cookers was placed in February 2006. This project was completed in March 2006. After encouraging feedbacks from the users, in 2007, tribal ministry made provision for 300 community cookers. Because of some administrative issues at the state nodal agency, there was a delay in placing the order. The order was placed by MEDA in February 2007 for 300 community cookers. With 300 community solar cookers, comprising of 1200 sq m of aperture area, this might be the single largest order for solar cookers in the world. This project was executed in record time of 45 days.

The challenges during the execution of the project were as follows.



a. Strict time frame: Only 45 days were permitted to carry out all the functions of material procurement, manufacturing, transportation to sites of tribal schools, installation, commissioning, test and trial at the schools, and collecting feedbacks regarding 7 days trials.

b. Inspection of the installed systems by MEDA authorities during the same time frame.

c. All the installation sites were tribal residential schools, scattered all over Maharashtra. Reaching these schools itself was a big challenge.

d. Many sites in the Gadchiroli district have naxal areas. Installation teams were not permitted to travel at night and stay at any tribal schools. There was a lot of interference from the police authorities. At one site, a bridge was blasted by naxalites and it was not possible to reach the site. Ultimately, the authorities gave alternative site.

e. It was impracticable to get any payment during the execution of the project and hence, organizing the total amount of more than Rs 65 lakh in 20–25 days was a challenge.

The authors accepted the opportunity as a challenge and could complete the project in record time.

Table 1 Results of the performance test

Testing period	*Recipe*	*Ingredient (in gm)*	*Water (in ml)*	*Time taken (in minutes)*
March 2005	*Khichadi* (rice 2.5 kg + pulse 0.5 kg)	3000	6000	55
January 2007	*Khichadi* (rice 2.5 kg + pulse 0.5 kg)	3000	6000	60

*A 22-litre-capacity pressure cooker was used for the test.

Table 2 Results of the stagnation temperature test

Test duration	Time to reach stagnation temperature	Stagnation temperature (in °C)
March 2005	32 min.	266
March 2005	42 min.	257
January 2007	55 min	246

*Stagnation temperature depends on the wind speed and solar insolation during the test period as well. All test results indicate stagnation temperatures in the range of 250°C.

Following were some of the ways to overcome the different challenges.

i. Prof. Chandak took over as the project coordinator and all activities were planned for 45 days. Adequate provision was made for uncertainties in the naxalite-prone areas.
ii. Finance was raised from all possible sources, especially from friends and relatives. Credit purchase was obtained from routine suppliers.
iii. All purchases were organized within first 15 days.
iv. Three workshops were rented, apart from the manufacturing set up of Rahul Kulkarni.
v. Twenty-five teams were formed with many temporary appointments. During the initial production time, these team leaders were given training for installation, commissioning, and test and trial of the system. Special 'daredevil' teams were chosen to work in the naxalite-prone areas and these teams did not let us down.
vi. Special supervisory staff was trained and appointed for taking the MEDA staff around for inspection of the systems.

With all valiant efforts, it was possible to complete the assignment within the stipulated time.

This project gave confidence to the authors that projects of bigger magnitude with tight timeframes can be accepted and executed.

Recent developments

The SK-23 cooker is gaining popularity and is now also available on rate contract of the Government of Maharashtra. With feedbacks from the existing manufacturers, it was noted that this system is to be transported as a unit and being bulky in size, transportation cost is high. Prof. Ajay Chandak has now designed and introduced new range of solar community cookers of 3 and 4 sq m aperture area as a substitute for SK-20 and SK-23. These are termed as PRINCE-30 and PRINCE-40 community solar cookers. Special features of these cookers are as follows.

a. Available as DIY (Do It Yourself) kit. This feature reduces the cost of installation to a large extent. Also, installations in remote hilly region and border areas are possible.
b. This is available in knock-down assembly and can be packed in small boxes. This has improved transportability. This feature makes it possible to transport and install the cooker anywhere on the globe.
c. Unique square or rectangular dish shaped design.
d. Design based on patent pending by Prof. Ajay Chandak.
e. Cooking performance of PRINCE-40 indicates its suitability for around 40 people. It can cook 5 kg of rice in 45 minutes and 5 kg of potatoes in 65 minutes. This concentrator has been tested for other applications like Autoclaving at Shri Bapusaheb Hire Government Medical College, Dhule, and results were satisfactory. The product has also been tested at the Pune University.

Conclusion

With experiences during the development and promotion of community parabolic dish cookers – SK-20, SK-23, PRINCE-30, and PRINCE-40 – authors are now confident that such simple technologies can deliver big promise in emission reduction when adopted on a large scale. These systems do not have the indoor operating convenience of Scheffler concentrators, but because of the huge cost advantage and the ease of operation and maintenance, these systems are easily acceptable.

Probably, world's largest solar cooking project was executed with very simple technology using 360 SK-23 community dish cookers, contributing to 1440 sq m of aperture area. It is projected that with 360 installations already made at tribal schools in Maharashtra, there can be LPG savings worth 54 tonnes per month.

The project with the tribal ministry also demonstrated that with proper planning and organizing of human resources, large numbers of installations are possible in very short time. The project demonstrated that all other schools where mid-day meals are provided can successfully adopt this solar technology. Few more entrepreneurs will be required to promote the technology in other states as well. With the introduction of these new PRINCE-30 and PRINCE-40 cookers, the transportation inconvenience of SK-20 and SK-23 is now taken care of. It is very likely that PRINCE-30 and PRINCE-40 cookers will replace SK-20 and SK-23 cookers because of better performance and transportability.

With some sort of subsidies provided for these promising products from the governments, large-scale implementation is possible. Recognition will be required for the product from MNRE (Ministry of New and Renewable Energy) so that the adoption of the product is possible by other agencies.

Biomass briquettes

Replacing coal and LPG

BRIJESH RAWAT, RURAL RENEWABLE URJA SOLUTIONS PVT. LTD

India is extremely dependent on the use of fossil fuels, mainly coal and petroleum. The dependency is even more evident in the semi-urban areas. On the one hand, several small-scale industries such as brick kiln manufacturers, industrial boilers, and food processing and pharmaceutical industries use coal for thermal/heating purposes, which results in high greenhouse gas emissions, which are responsible for climate change. On the other hand, institutional kitchens use expensive and polluting LPG (liquefied petroleum gas).

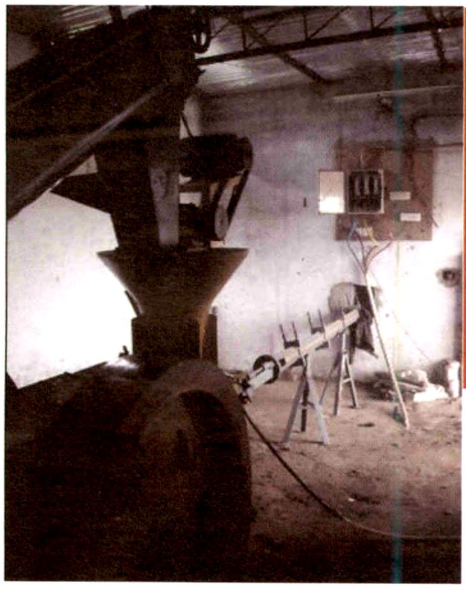
However, the rural population in India does not have access to reliable energy. The main source of energy for this section of the society is the use of firewood. The people living in rural areas burn firewood inefficiently (mainly for cooking), which causes indoor air pollution and releases harmful black smoke. Thus, only unreliable and dirty energy is available to the rural population and industries in semi-urban areas.

Solution

India has millions of tonnes of unused and available biomass waste. This loose biomass is currently treated as a waste with no economic value. It is often burnt inefficiently in open fields, causing air pollution. However, this 'waste' can be turned into a completely environment-friendly source of energy through briquetting.

Briquettes are simply compressed biomass material, which can be used for heat and electricity generation. Unused, loose, and low-density biomass can be briquetted to a bulk density of more than 650 kg/cu m. Biomass briquettes can be used for small and big thermal installations, replacing coal and LPG. This, in turn, results in significant emission reduction.

Biomass briquettes can also be used in small- and big-scale smokeless *chullhas* that are based on the gasification technology for commercial cooking, as well as at home, replacing LPG and firewood. In addition, they can



Biomass in Uttarakhand

Unused pine needles from the forests in the state of Uttarakhand amount to 1.8 milion tonnes, says the state forest department. If this quantity can be properly briquetted, it can produce approximately 5 940 000 megawatts of energy every year. And it will result in enormous CO_2 savings. For instance,

- 1.3 tonnes of biomass briquettes replaces 1 tonne of coal used by brick kiln, saving of 1.81 tonnes of CO_2 emissions.
- 2.5t of biomass briquettes replaces 1 tonne of LPG, saving 2.98 tonnes of CO_2 emissions.

be utilized in bio-digesters and gasifiers for decentralized power generation.

Sustainable development

The use of briquettes based on biomass, a renewable source, will reduce the amount of CO_2 (carbon dioxide) emitted due to the burning of fossil fuels like coal and LPG. In addition, the collection and densification of biomass will generate income for the rural people, as well as provide a clean energy for the local industry in an environmentally sustainable manner.

Current project

Currently, one project is underway at Kotdwara, Uttarakhand. It has a capacity of producing 15 000 tonnes of briquetted biomass per year. And it would lead to a carbon offset of around 20 000 tCO_2/year (total CO_2 per year). Not only this, more than 400 people – mostly women in rural areas – will also be employed.

Areas of biomass availability have been identified and biomass collection centres, with small grinder facility, are being set up.

The aim of this project is to save 20 000 of tCO_2 emissions annually from the Kotdwara Unit—12000 tCO_2 against coal replacement in brick kilns and 8000 tCO_2 against LPG replacement.

Social and economic benefits

Biomass will be collected in isolated rural areas where unemployment, poverty, and other economic backwardness prevailing.

- The project would lead to the development of the region through the generation of employment in these regions.
- It will provide economic value to biomass, agricultural biomass, and so on.
- It would provide renewable and sustainable energy to the industry and aid in hassle-free manufacturing of products.
- It will help rural population to have access to low-cost new *chullha* technology to burn biomass efficiently, while reducing the pollution drastically.

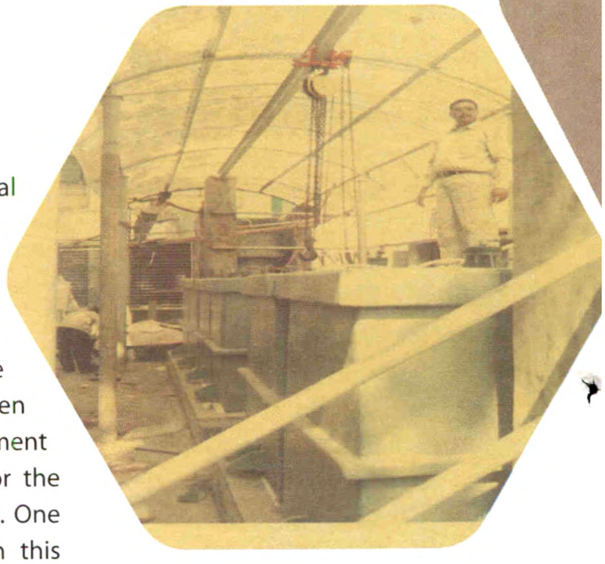
Win–win for all

- Complete mobilization that can generate an employment of around 500 people during the peak season of biomass availability.
- Preservation of forest from fire.
- Additional income generation for transporters.
- Employment generation opportunity at the production and *chullha* manufacturing facilities.
- Saving for coal and LPG users, as briquettes are less expensive than coal/LPG.
- Help in overcoming the availability crisis for LPG/coal.
- Saving environment by controlling carbon emission.

The way ahead

The franchise model will be used replicating the same project in different regions. About five sites have been identified in Uttarakhand and Himachal Pradesh that have the required biomass and the industry that needs a clean energy alternative. The model will be eventually extended to different states of India.

'TEAM' for organic waste treatment



The problem of waste disposal and compliance with the Solid Waste (Management and Handling) Rules 2000 in India has cropped up as a challenge for the hotel industry, institutional canteens, as well as for townships. This is also due to the non-availability of technologies that are suitable for the Indian conditions. In addition, the imported technologies are too expensive.

It is apparent that the segregation of the waste at source is the key solution to the problem of solid waste management. In this regard, many state governments have launched several campaigns to make people aware about the importance of waste segregation. Further, governments and NGOs (non-governmental organizations) have also placed colour-coded dustbins along the roadsides for demarcating organic and inorganic wastes. Many corporate houses, NGOs, and voluntary organizations are stepping forward to deal with the problem of solid waste management. This would not only enable them to comply with the Solid Waste (Management and Handling) Rules 2000 and the Citizen's Charter, but also add on to their 'green rating'.

Thus, realizing the potential of domestic waste, fruit and vegetable market waste, and semi-solid municipal waste, and the non-availability of a decentralized system for the treatment of these, efforts have been directed towards the development of an appropriate technology for the digestion of organic solid wastes. One of the organizations working in this field is TERI (The Energy and Resources Institute). TERI is involved in the development of various technologies for solid and liquid waste treatment through anaerobic digestion. And it has established a process – TEAM (TERI's Enhanced Acidification and Methanation) – for the treatment of organic solid wastes (Patent no. 2655/Del/97).

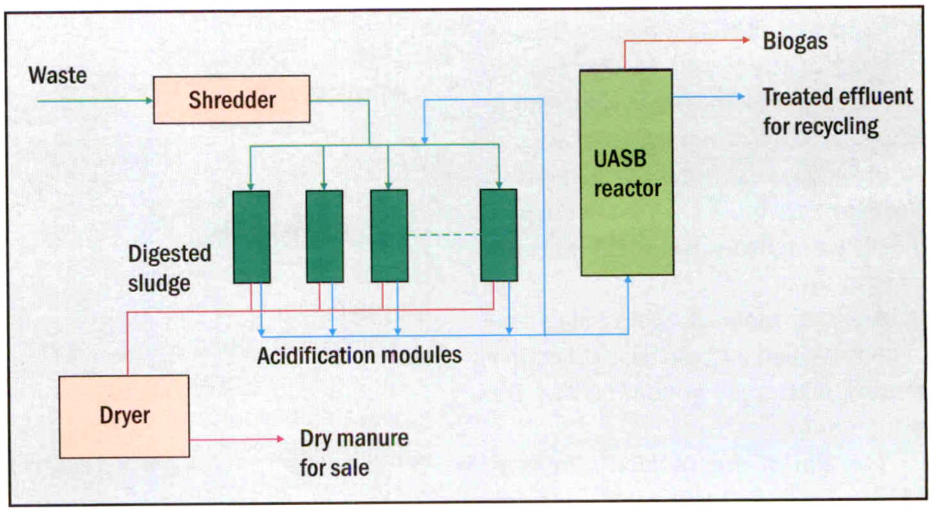


Figure 1 Schematic diagram of TEAM process

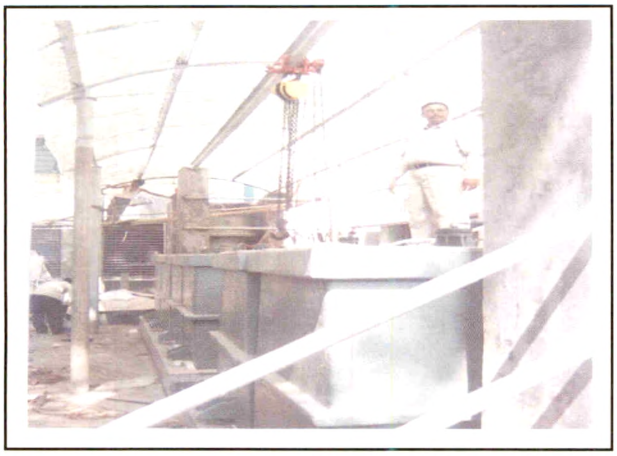


Figure 2 TEAM digester at CIDCO, Navi Mumbai

The TEAM process is a two-stage-process comprising of acidification and methanation (See figure1). In the acidification phase, the organic content of the solid waste is leached out to make a high strength liquid by the decomposition of the waste with intermittent sprinkling of water. In the methanation phase, this high strength leachate is treated in a high rate UASB (Upflow Anaerobic Sludge Blanket) reactor to produce biogas. The process has been designed to overcome the basic hurdles experienced in conventional anaerobic digesters such as scum formation, floating of waste, long retention time, and so on. Also, the separation of the acidification and the methanation phases can solve the problem of control of pH (pondus Hydrogenii) during the methanation phase of digestion.

The digester has been successfully tested for different types of solid wastes for generating useful resources like biogas and manure. The promising results ensure the viability of the technology for wastes from varied sources. Based on the studies, food waste from hotels and canteens was found to have the maximum potential for biogas generation.

The volume of waste reduces to 10% after digestion and the sludge is dried to produce good quality manure. Due to its unique design and biphasic nature, the technology can treat any kind of organic waste within a short HRT (Hydraulic retention time) of seven days without the use of mechanical mixing. Its uniqueness also lies in its capability to recycle the water within the process and the production of non-flowable slurry after digestion of the waste, which results in reduced water consumption and improves the aesthetic conditions around the plant.

Salient features of TEAM

- High rate methane-producing reactor.
- Low HRT of 7 days.
- Digested waste has high NPK (nitrogen, phosphorus, and potassium) values.
- High methane content in biogas (>75%).
- Elimination of scum formation—a feature in small size plants.
- Production of non-flowable/ semisolid digested residue.
- Suitable for small and decentralized application.
- Very low water requirement due to recycling within the process.
- Aesthetic look with low maintenance cost.
- No environmental impact.
- Successfully tested for leafy waste, food waste, press mud, food processing waste, tea waste, vegetable market waste, township waste, and so on.

BETA (Biomass Energy Technology Application) group of EETD (Energy Environment Technology Development) division in TERI is aggressively involved in the dissemination of the technology at various capacities. Simultaneously, it is also engaged in the development of technological packages for urban and rural applications and the establishment of product potential of future energy crops like sweet sorghum and sugar beet. Table 1 indicates the list of ongoing field implementation/ installation projects.

The technology is suitably designed for the treatment of organic waste in a decentralized manner for the recovery of resources. TEAM is ready to be adopted in any part of the world, except

Table 1 TEAM process installation

Site address	Capacity	Feed stock	Status
CIDCO, CBD Bela Pur, Navi Mumbai–400614. Ph 00-91-22-55918100 Contact person: R S Nayak, Executive Engineer	250 kg/day	Canteen waste	Operational since February 2009
Sona Koyo Steering systems ltd. 38/6 Delhi-Jaipur Road, NH-8, PO Box No. 18, Gurgaon–122001 (Haryana) Ph: 91-124-4104601-08 Contact person: S S Dhingra, DGM	100 kg/day	Canteen waste	Operational since April 2007
NTPC, Faridabad Gas Power Project, Rashmi Puram, PO Neemka, Faridabad, Haryana–121004 Ph: 01292403950 Contact person: DGM (EMG)	50 kg/day	Township waste	Operational since June 2006
TERI, Gual Pahari campus, Gurgaon, Haryana	50 kg/day	Canteen waste	Operational since 1999
In process			
NTPC, National Capital Power Project, Gautam Budh Nagar, Dadri, Uttar Pradesh Contact person: A K Bhattacharya, Sr. Engineer (CS)	500 kg/day	Township waste	Ongoing
IOCL, R&D center, Sector 13, Faridabad–121007 Ph: 0129-2283702, 2283707 D S P Dubey, DGM	50 kg/day	Canteen waste	Ongoing
Gujarat State Fertilizers and Chemical Ltd, P O Fertilizer Nagar, Vadodara, Gujarat– 391750 Ph: 0265-3093466 Contact person: M J Shah DGM (Civil)	250 kg/day	Canteen waste	Ongoing
NTPC, Singrauli (Shakti Nagar, Distt Sonebhadra) Uttar Pradesh–231222 Ph: 05446-232411/232430 Contact person: Sr. Manager (CS)	250 kg/day	Township waste	Ongoing

for extremely cold regions. The target areas could be any source of organic waste such as industrial canteens, townships, vegetable markets, small cities, food and fruit processing units, sugar industries, and so on.

Table 2 Cost and land requirement for TEAM process

Capacity of the plant (kg/day)	Cost (Rs in lakh)		Land requirement (m^2)
	Brick and mortar	Mild steel with epoxy	
50	–	3.9	50
100	–	5.5	75
250	–	6.0	100
500	5.1	7.5	150
1000	9.5	13.5	200
2000	11.7	17.0	–

Case studies

Plant at NTPC for household waste

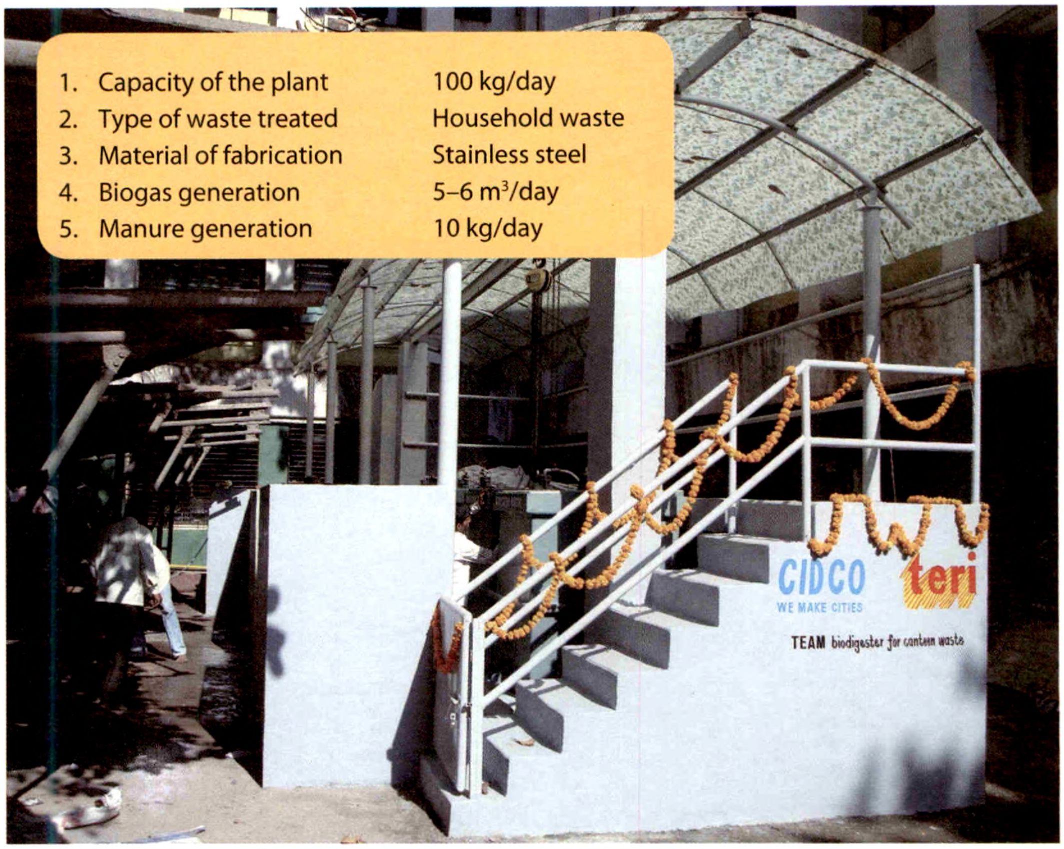
Influenced by the features of the TEAM process, NTPC (National Thermal Power Corporation) Faridabad Gas Power Plant decided to treat its waste with the help of the TEAM process. For the successful continuous operation of the plant, the management of the NTPC organized an awareness programme to inculcate the habit of segregation of organic waste among the residents at the household level. This practice helped them to dispose of their waste appropriately, at the same time, serving the dual motives of production of biogas and manure from the organic waste and to enhance hygienic condition within the campus. This is indeed an exemplary effort shown by the NTPC, Faridabad, towards the 'citizen's charter' chalked out in the honourable Parliament of India as well as towards social responsibility.

Waste is procured from the township and the guesthouse. These two locations generate approximately 50 kg of organic waste per day. The biogas produced from this waste is being utilized in a hospital and the manure is being used for horticultural purposes. Specifications of the plant are as follows.

1. Capacity of the plant	50 kg/day
2. Type of waste treated	Household waste
3. Material of fabrication	Mild steel
4. Biogas generation	2–3 m^3/day
5. Manure generation	5 kg/day

Plant at Sona Koyo Steering Systems Ltd, Gurgaon, for canteen waste

SKSS (Sona Koyo Steering Systems Ltd) had a conventional biogas plant for the treatment of its canteen waste, which was not functioning properly for a long time. After learning about the TEAM process and its salient features, the management of the company decided to replace their conventional plant with the TEAM process. SKSS serves meals to their 2000 staff members in three shifts. During this exercise, a huge amount of waste is generated. Approximately 100 kg of waste is being produced daily by the canteen. The disposal of the waste was a major problem for the company. After the installation of the TEAM process, their waste disposal problem has not only been solved, but it has partially replaced their LPG (liquefied petroleum gas) with biogas. And the plant is performing excellently since the time of installation. Specifications of the plant are as follows.



1.	Capacity of the plant	100 kg/day
2.	Type of waste treated	Household waste
3.	Material of fabrication	Stainless steel
4.	Biogas generation	5–6 m^3/day
5.	Manure generation	10 kg/day

Courtesy: TERI

Inviting articles for Akshay Urja

The need to have a sustainable supply necessitates the exploitation of available energy sources, and among these, renewable resources are at the forefront. It is now an established fact that RE (renewable energy) can be an integral part of sustainable development because of its inexhaustible nature and environment-friendly features. RE can play an important role in resolving the energy crisis in urban areas to a great extent. Today RE is an established sector with a variety of systems and devices available for meeting the energy demand of urban inhabitants, but there is a need to create mass awareness about their adoption. *Akshay Urja* is an attempt to fulfil this need. 20 000 copies are being disseminated in India and abroad.

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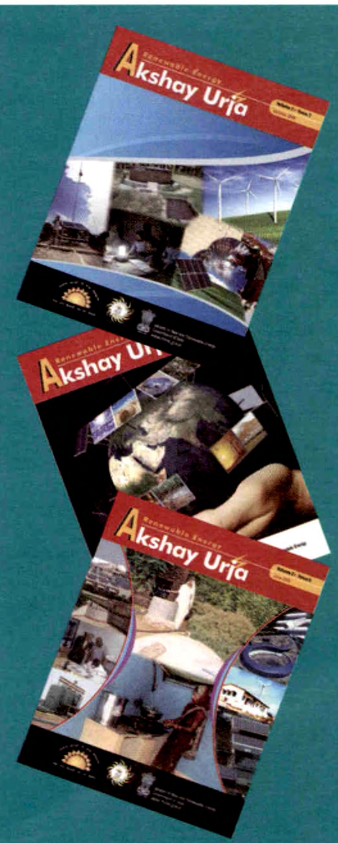

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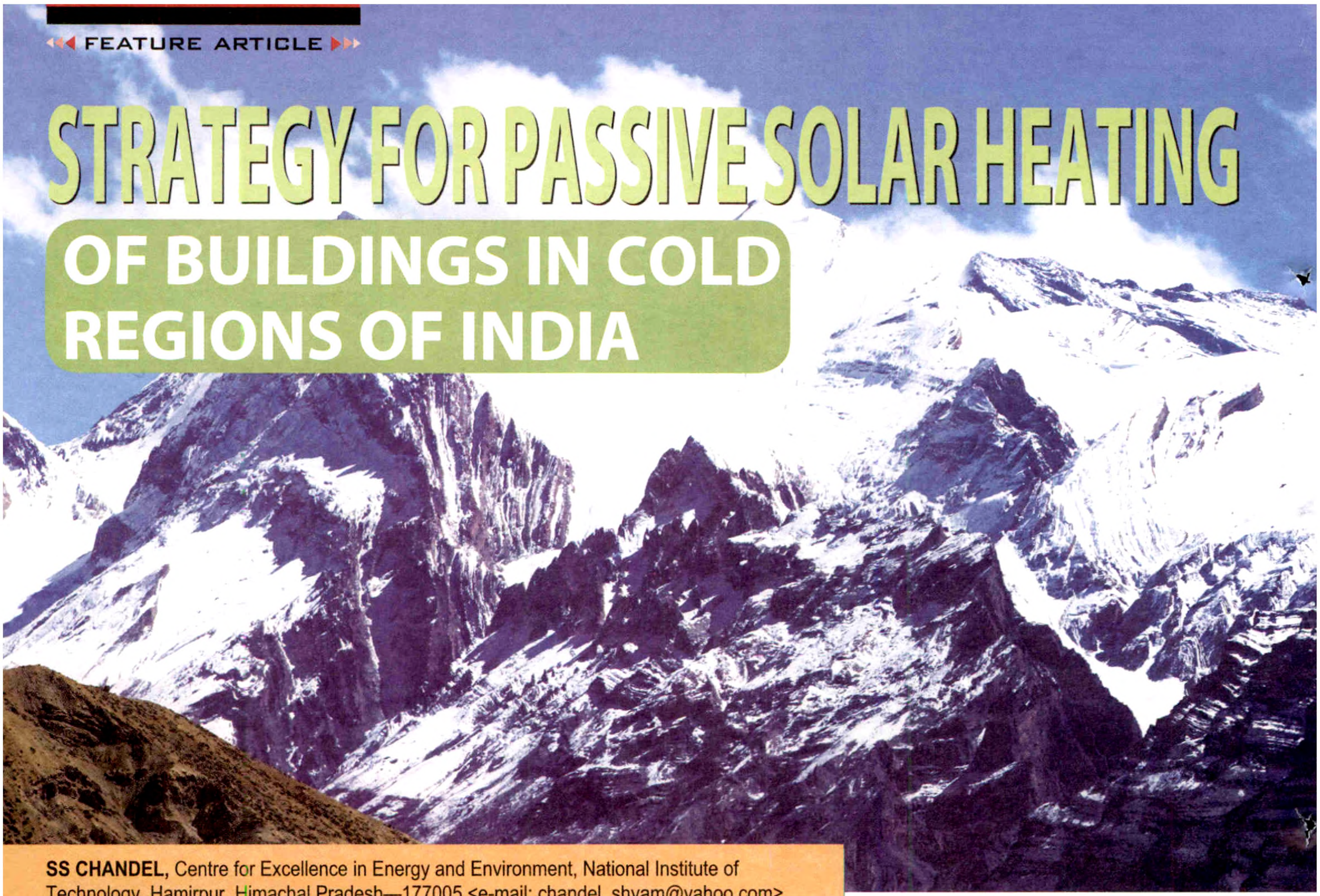


STRATEGY FOR PASSIVE SOLAR HEATING OF BUILDINGS IN COLD REGIONS OF INDIA

SS CHANDEL, Centre for Excellence in Energy and Environment, National Institute of Technology, Hamirpur, Himachal Pradesh—177005 <e-mail: chandel_shyam@yahoo.com>

Abstract

Passive solar heating of houses is a clean technology which was made mandatory in the government/semi-government sector in 1994 in the Western Himalayan state of HP (Himachal Pradesh). HP is the first state in India to take such a policy decision for promoting energy efficiency in buildings. A Solar House Action Plan was formulated and is being implemented effectively in the state. A large number of buildings were designed and constructed through a massive awareness campaign among engineers, architects, and the public. Based on the successful implementation, another decision was taken in June 2009, vide which solar passive heating technology features have been incorporated in the building byelaws and solar passive heating features have been made mandatory in the government/semi government and commercial sectors. The strategy adopted, which is promoting energy efficiency, providing comfort, and ensuring sustainability, is outlined in the present study. The results of the field survey of constructed solar passive buildings in Shimla and Spiti valley of the state is presented. A strategy for the implementation and sustainability of the technology is outlined for the cold regions.

Introduction

The state of HP lies in the Western Himalayas and extends from the snow-covered mountains separating Tibet in the north to the plains of Punjab in the South and West. The state, with a geographical area of 55 673 sq km, is located between latitude 30° 22′ 40″ to 33° 12′ 40″ North and longitude 75°45′ 55″ to 79o 4′ 20″East. The altitude ranges from 250 m to 6975 m above mean sea level. Due to the peculiar topography and snowfall in high the altitude areas, the state experiences severe winters. Areas above 2000 m receive light to heavy snow fall, whereas the alpine zone remains under snow for 5–6 months in a year.

About 92% of the state's population lives in villages and largely depends on fuelwood for space heating, water heating, and cooking. About 4.82 million tonnes of fuelwood is used in the state annually for cooking, space heating, water heating, tarring of roads, and so on, out of which 4.5 million tonnes is used by the rural population. This requirement has resulted in large-scale denudation of forests posing serious threat to the environment. Wood, charcoal, coal, kerosene, LPG (liquefied petroleum gas), and electricity are mainly used for cooking and space heating during winters. In the tribal areas of the state, fuelwood, coal, and kerosene are supplied on subsidy to the public, resulting in serious burden on government exchequer.

In high altitude regions, government buildings like offices, hospitals, require electricity-/fuelwood-/fossil fuel-based heating systems to create comfortable indoor conditions during winters. The installation and annual running costs of such heating systems are quite high. This cost can be considerably reduced if a building is designed incorporating solar passive features. About 250–300 sunshine days per year are available in HP, with 7–8 mean sunshine hours per day. And as such, solar energy can effectively be utilized for space heating.

Solar passive housing incorporates features like orientation, passive heating or cooling systems, and the use of appropriate building materials in order to conserve energy used in heating, cooling, and interior lighting of buildings utilizing Sun's energy effectively. In a cold climate, the strategy is to maximize heat gains from the Sun, make provision for heat distribution, store Sun's energy within the building, and minimize heat losses.

Solar building design strategy also includes use of natural light for day-lighting, which reduces electricity consumption. The government sector is the biggest consumer of energy for space heating and day-lighting in buildings in cold regions. The adoption of this technology not only creates comfortable living conditions but also results in the saving of conventional fuels like fuelwood, coal, charcoal, and electricity required for winter heating.

Implementation strategy

Policy decision 1994

In order to implement the solar passive housing technology in HP, a policy decision was taken by the HP government in 1994 that all government and semi government buildings in HP will be designed and constructed using passive solar design features in a phased manner. Thus, HP became the first state in the country to take such a policy decision. A Solar House Action Plan with detailed implementation guidelines were formulated by the State Council for Science, Technology, and Environment. A Technical Project Management Cell was set up in the Council to implement the Solar House Action Plan in coordination with state housing agencies.

Technology demonstration

In order to demonstrate the efficacy of the solar passive technology for winter space heating, 25 government buildings were identified for which the government funds for construction were available. A team of experts were involved with the architects and engineers of the concerned agencies for the preparation of the building designs after carrying out the detailed micro-climate and site analyses. The constructed solar passive buildings were monitored during winters for thermal comfort evaluation. The solar radiation data which is required for the simulation of solar buildings was generated using sunshine hour data. The retrofitting of houses with passive solar heating systems in high altitude areas of Bharmour, Spiti, and Kinnaur was carried out.

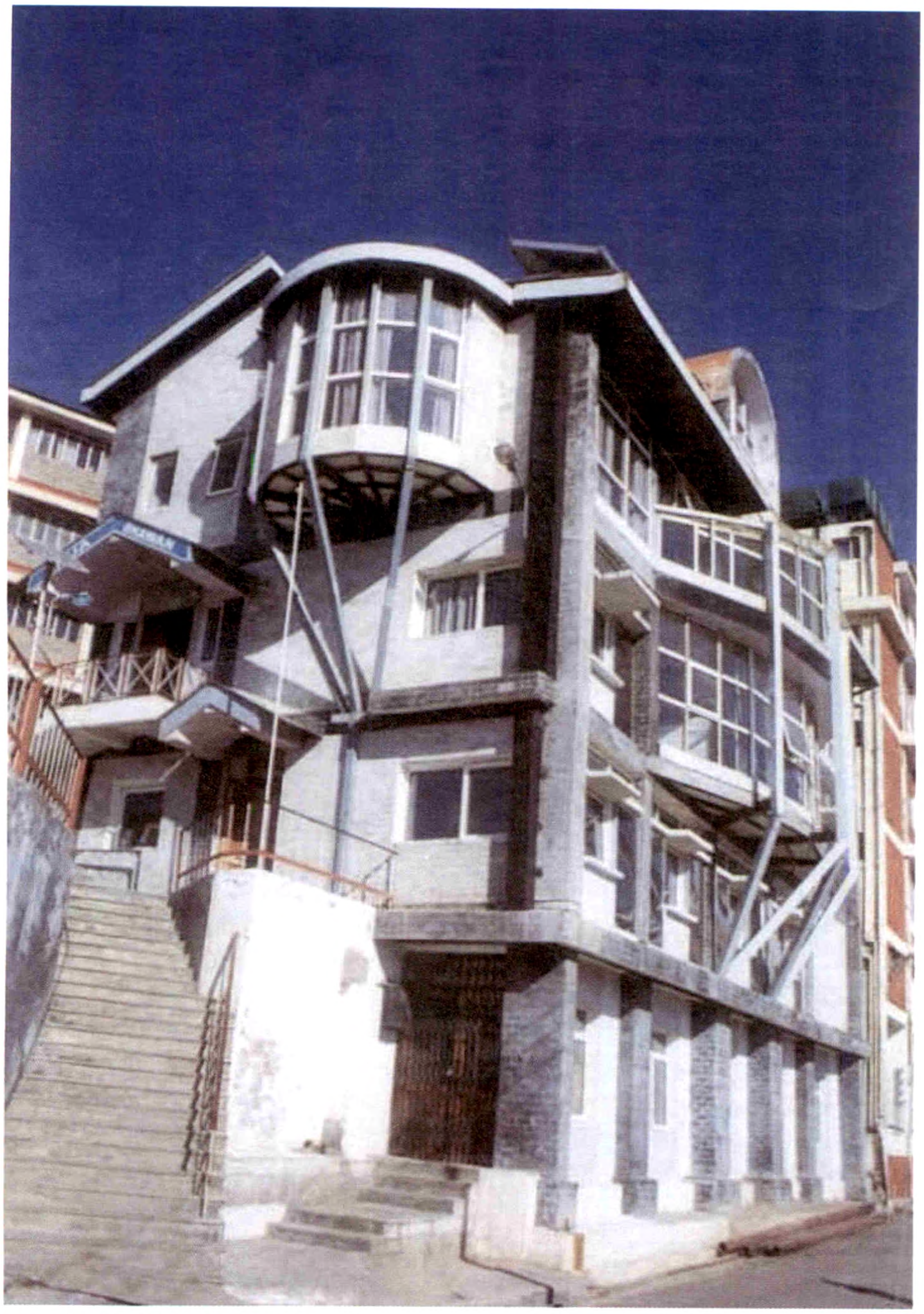
Ensuring trained technical manpower

Specialized training programmes were organized by the Council for the architects, engineers, scientists, masons, carpenters, and builders for the sustainability of the programme. The carpenters and masons were trained in the construction of cavity walls, trombe wall, thermosyphoning air heating panels, and space heating green houses for the sustainability of the programme in rural and high altitude regions.

The solar passive design features have been incorporated in the building byelaws so that the technology is adopted in all buildings like hotels, industry, and houses.

Funding

The solar passive building programme was financed by the HP government, along with the MNRE (Ministry of New and Renewable Energy), Government of India. The funds were obtained only for capacity building, training, and fabrication of solar heating systems. The funds for building construction were provided by the concerned housing agencies or the house owners. The funds provided by the MNRE for detailed project report preparation



Himurja Office Building, Shimla

and for incorporating solar passive features in the buildings were utilized for demonstration buildings.

Policy decision 2000

Based on the successful demonstration of the solar passive housing technology, the HP government took a policy decision on 18 August 2000, vide which all the departments including corporations, boards, universities, public works department, and HP Housing Board were directed to design and construct all the new buildings above 2000 m by incorporating solar passive design features.

More than 200 solar passive buildings, including offices, hospitals, schools, houses, were constructed. The monitoring of the constructed solar buildings was also carried out for thermal comfort and energy saving potential. The experience gained in implementing the technology was shared with some states, namely Uttrakhand, Sikkim, Manipur, Nagaland, and Arunachal Pradesh.

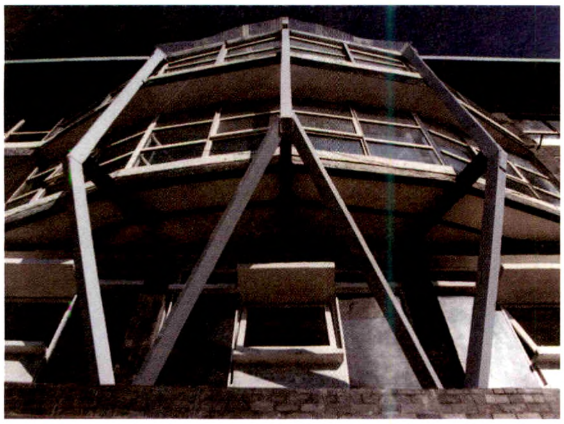
Policy decision 2005

The solar passive building programme was reviewed by the state's chief minister on 14 October 2005 and a decision was taken that all buildings, industrial complexes, tourist resorts, hotels in the government/semi-government and private sectors must incorporate solar passive heating and cooling, earthquake-resistant and rainwater harvesting structure features in all the buildings in HP. It was also decided to set up computerized design cells in government agencies, besides modifying building byelaws for making provision for solar passive features, solar space heating systems, solar access to buildings, colonies, and new townships by the Department of Town and Country Planning, municipal corporations, and other concerned agencies.

Based on this decision, a committee was constituted by the government consisting of representatives from the Science and Technology Council, HPPWD (HP Public Works Department), HIMUDA (Himachal Pradesh Housing and Urban Development Authority), Town and Country Planning Department, and municipal corporation, Shimla, to incorporate passive solar features in building byelaws. The committee recommended the modification of building byelaws.

Policy decision 2009

Based on the recommendations of the committee, the state government took a policy decision on 27 June 2009 vide which solar passive features have been made mandatory throughout the state government/semi-government and



A closer view of the solarium at Himurja Office Building

commercial sectors, including in hotels, residential colonies, and industrial complexes which are large consumers of energy. Thus, for the effective implementation of a technology, a long-term strategy has to be worked out with a continuous back-up of policy decisions by the government.

Thermal comfort evaluation

The monitoring of the constructed solar passive buildings was carried out to study the thermal comfortable conditions, efficacy of solar passive features, and actual energy savings. The monitoring of constructed solar passive buildings in the state shows that the buildings are comfortable in winters and the dependence on electricity for heating has been reduced considerably. The users have also expressed satisfaction over the comfort level.

Himurja office building

The building located at Shimla exposed to winter Sun has day-lighting features, sunspace, thermo-syphoning heating panels, double-glazed windows, solar water heating, and solar photovoltaic lighting features. This building does not require any auxiliary heating in winters. The monitoring of building shows the inside temperatures as 18 °C to 28 °C with ambient temperature variation from 9 °C to 15 °C.

Solar passive buildings in cold desert regions

A number of solar passive schools, teachers' hostels, and rural houses have been constructed in Tabo, Kaza, Sagnam, Dhankar, Rangrik, Kibber, Hansa, and Losar in Spiti Valley at altitudes from 12 500 ft to 14 500 ft, where the minimum temperature drops to -40 oC in winters. The Solar Trombe wall, which is effective in providing nighttime heating, was installed at the Tabo Monastry Residential Complex.

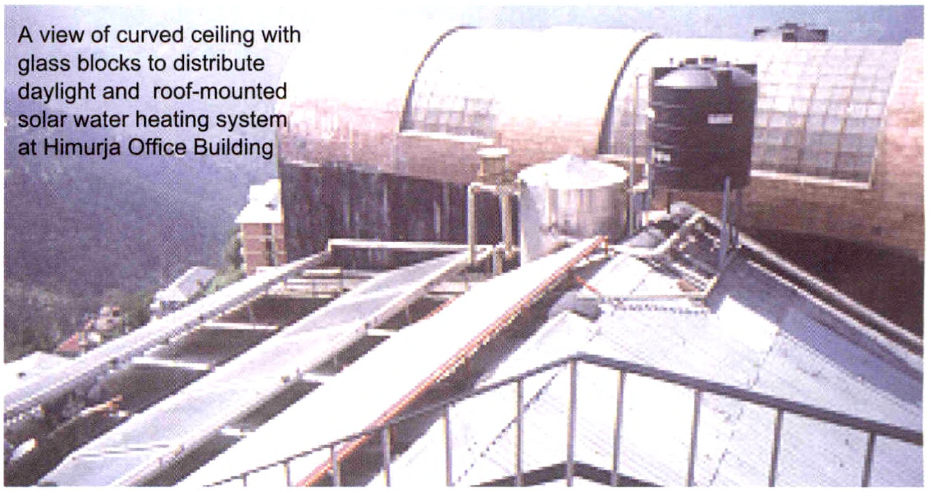
Retrofitting of traditional houses

Under the plan, a number of traditional houses were retrofitted with thermosyphoning air heating panels, sunspace, and Trombe wall heating systems in Sangla Valley, Kinnaur district, and Bharmour, Chamba, which resulted in wider awareness and acceptability by the people. A training centre for women was retrofitted with a sunspace which resulted in providing comfortable working space for rural women during winters.

Discussion and follow-up

In the solar passive buildings constructed in the state, there is only a marginal, increase in the cost ranging from 0% to 10% depending on the nature of solar passive features adopted. This minor increase in the cost further reduces if proper site planning, designing, and selection of materials are done at the initial stages. Due to continuous saving of fuel/electricity required for space heating/cooling in such buildings, this additional cost can be recovered within 2–3 years. The solar passive building programme has been implemented in the western Himalayan state of HP successfully and the experience gained can be replicated not only in the hilly states of India but also in other cold regions of Asia, like Tibet, Nepal, China, Afghanistan, and so on. The adoption of environment-friendly solar passive housing technology for space heating in the entire Himalayan region countries will lessen the burden on fuelwood, saving the forests from extinction besides creating a pollution-free environment and decreasing greenhouse gas emissions.

Although it is difficult to change the mindset for adopting the new technological inputs and orient the architects and engineers, especially in the government sector, long-term technological backup, continuous thrust and zeal to promote this technology, and ensuring the availability of motivated technical manpower are essential to sustain the programme.



A view of curved ceiling with glass blocks to distribute daylight and roof-mounted solar water heating system at Himurja Office Building

Empowering Villages by solar photovoltaic

AMITABH VERMA, Scatec Solar India Pvt. Ltd <E-mail: amitabh.verma@scatec.no>

Abstract

The present article shares the experience of deploying CSPP (Community Solar Power Plants) by a private enterprise in two villages of India. The article touches upon various aspects of village electrification, such as village mobilization, capacity building, technical solutions, and project execution. The impact of electrification on village development and economy are qualitatively described. The article summarizes the key learnings, the future prospects of CSPP, and the recommendations for the future deployment in order to make similar projects successful.

Concept introduction

26 January 2009, the 60th Republic Day of India, will go down as a milestone event in the annals of Rampura—a small hamlet in Jhansi district, Uttar Pradesh. Since then, the hamlet dwellers are envied by the villagers of all neighbourhoods. Rampura is the only village in the area which has uninterrupted round-the-clock power supply since 26 January 2009. Rampura twinkles at night like a bunch of fireflies in a forest. The street lights, connected to an automatic switch, are switched on every evening and get switched off in the morning.

Scatec Solar, a Norwegian company, on its own initiative electrified two villages – Rampura and Gopalpura – in the Jhansi district by solar energy in early 2009. The uniqueness of this initiative is that the whole system of power generation and distribution is solely managed by the community through a VEC (Village Energy Committee). Scatec Solar engaged DAs (Development Alternatives), a well-known non-governmental organization, for village mobilization and capacity building. A Gurgaon-based electronics company, DD Solar 23 India Pvt. Ltd, under the banner of Bergen Group, provided the engineering know-how and execution of project on a turn-key basis. Rajinder Kumar Kaura, Chairman and Managing Director of the Bergen Group, was instrumental in uplifting the village primary school by donating a television set and a personal computer for the children. He also contributed to upgrading of the school infrastructure by providing the playground equipment and other reading accessories to the students.

The underlying belief in these projects is that a combination of domestic and commercial loads has the potential to make the solar plants self-sustaining. The arrival of electricity shall help enhance the income generation opportunities so that the villagers can pay the cost of solar energy. Moreover, it goes without saying that the villagers will take good care of the solar plant when they know that their livelihood is dependent on the power produced by it.

Technical details

Two different technologies and distribution models have been adopted in the two villages. The Rampura plant uses crystalline silicon solar plants, whereas amorphous silicon thin film modules have been used in Gopalpura. The plant capacity in Rampura and Gopalpura are 8.7 and 9 kWp, respectively. Similarly, two different distribution models have been tested in the villages. Rampura supplies power to individual homes through a 0.75-km-long mini-grid, whereas Gopalpura has energy services in the form of charging hubs for charging mobile batteries, lanterns, and mobile phones. Both the villages have approximately 70 houses.

Rampura

This off-grid PV (photovoltaic) system is a self-sufficient system. It feeds power to the household loads from its self-created local grid for the particular design area and AC (alternating current) power can be fed to a cluster of houses from multiple points. The major advantage of this system is that various other sources of non-conventional energy can be tapped and connected to this local grid. For example, if the load goes up in future, a gasifier or any other generator can be hooked to the system to meet the enhanced demand. The DC (direct current) power generated from solar array is converted into AC power with the high efficiency PCU (power conditioning unit). This power is pumped into the local, self-created grid. The grid supply is fed to local villagers' houses to run various appliances. The same grid is connected to a bidirectional inverter, which charges the battery bank through the power generated by the solar array. The batteries are essential for storing energy produced by PV array for nights or cloudy weather.

In the day time, when the PV array will be producing energy, the PV energy will be used to fulfil the power demand and the extra energy is used to charge battery through a bidirectional inverter. At night or during cloudy weather, when the sunlight is not available, the power required to operate the load is delivered from the battery bank. The bidirectional inverter feed battery power in to local grid. During peak load time, if power demand is greater than the PV energy produced, then extra power comes from the charged batteries. The battery autonomy is for three days.

Gopalpura

There are 100 thin film modules connected in series and parallel. The output from the array junction box is connected to a PCU, which gives AC and DC outputs of desired current and voltage. It supplies AC at 230volt and has a number of outlets for charging the 12-volt batteries, solar lanterns, and mobile phones. Ten 12-volt batteries and 15 12-volt lanterns can be charged simultaneously. There are 8 12-volt and 75 Ah (ampere-hour) batteries connected in series.

Project execution and sustenance

The responsibility of village identification and explaining the concept of CSPP to the villagers was assigned to the DA. The DA explained the concept to the villagers and got their acceptance for allocating land for the purpose. It conducted a survey to estimate the load requirements of villagers. Based on the load requirements, the solar system was designed and the requirement of land for the solar plant was given. The DA, in consultation with the villagers, identified the options in the villages. Scatec and Bergen surveyed the probable sites and gave their preference for the final site. With the consent of the villagers and official process of Gram Pradhan and Panchayat, the land was secured for the CSPP.

The solar system was designed and components were ordered. In the mean time, the DA mobilized the community and helped them form a VEC. The VEC had the representation of all castes and communities, and women in particular. A bank account was opened in the name of the VEC and the complete operation of the CSPP was explained to the villagers by conducting many evening meetings.

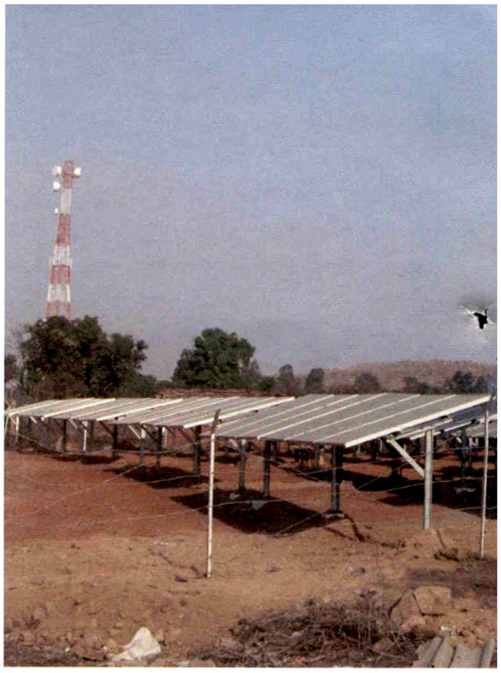
An application form was designed for securing the electricity connection. The tariff scheme was explained to the villagers and their consent for carrying out the electrical wiring on their own expenses within their house and payment of monthly electricity bills was taken. The expenses involved in the internal wiring were explained to them. A contractor for internal wiring was identified and the DA's role was to facilitate the internal wiring and ensure fair practice and quality work. Villagers were encouraged to participate in the construction of the plant so that the earnings through labour work can be used to meet the expenses of the internal wiring. Effort was to use as much local labour and material as possible with a view to increase villagers involvement and income generation. Bergen completed the installation and commissioning in record 30 days, including the civil work and laying of the mini-grid. In addition, Bergen also paid extra attention to the aesthetics of the installation and engagement of the villagers in the entire process by adopting the local primary school.

The plant was commissioned on the night of 25th January and inaugurated on 26th January in an unofficial function. All the villagers were invited to watch the Republic Day parade on the television and lunch was served subsequently. Both men and women participated in the event in large numbers and gave expression to their happiness in many different ways. One of the septuagenarian in the village said, 'After so many years, the cataract of Rampura has been removed.' Later, Erik Solheim, Norwegian minister for environment, along with Ann Ollestad, Norwegian ambassador to India, and many Government of India officials visited Rampura on 4 February 2009 and were full of praise for the quality and participation of the villagers.

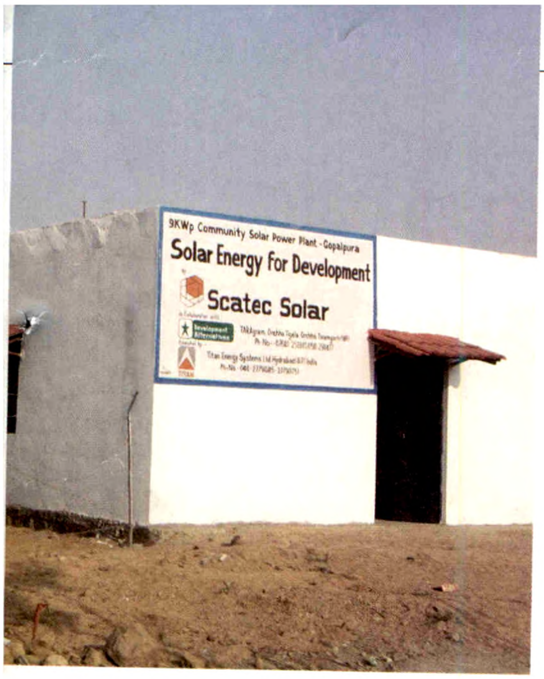
Ever since its commissioning, the plant has been working non-stop and its performance can be monitored in real time with a web-based monitoring system. On an average, it generates 900–950 units of electricity in a month. The plant supplies power to individual homes, a floor mill, and street lights. The consumption is metered, and while house owners pay for their monthly usage, the street lights are paid for by the entire village. The tariff has fixed and variable components. The variable component is based on meter-reading and structured in a manner that people with better paying capacity end up paying more than lower income group. The entire operation is managed by the VEC. It has appointed a village operator and a security guard. The village operator has been trained on the routine operation and maintenance, as well as meter-reading and monthly billing. The VEC is empowered to take its decision and the revenue from the plant is used for the operation and replacement of batteries in the future.

Impact assessment and key learnings

The impact of electricity in village development has been monitored for over 10–11 months. It is too short a time to conclude anything; however, there are indicators of growth and development. Some of the perceptible changes are students studying 1.5–2 hours more every day. A computer class has been started, which attracts students from the nearby villages as well. There were applicants for computer teaching from Jhansi city, which shows that given the opportunities in villages, reverse migration is possible. A micro-enterprise in the form of a flour mill has been set up, which has not only made the lives of the villagers more comfortable but has also improved the income level in the village. The village is livelier in the evening, and people enjoy watching television and are more informed now. A group of women have been initiated on literacy programme. The village is safer and better sanitation conditions are developing. Taking the advantage of darkness, people used to defecate on the roadside near the dwelling. This has considerably reduced and families are building toilets inside the home. People have bought new appliances like coolers, televisions, DVD players, and fans, and are thinking of buying fridge. They are no longer hesitant to marry off their daughters to the men in this village.



Gopalpura, which is only 20 km from Rampura, has presented another kind of challenge. Experience in Gopalpura is a mixed bag. People in Gopalpura were quite happy in the beginning when the energy services were introduced. There was a great demand for the lantern and people came forward for charging batteries and mobile phones. However, most batteries were abused or second-hand and it was not easy or possible to charge them. It is not a very homogenous community and most people work in the nearby mines. They are out of the village throughout the day and return home only in the evening. Drinking is a social evil in this village and most villagers are not as socially responsible as the people in Rampura. They find coming to the charging centre and carrying back the charged lantern and


9KWp Community Solar Power Plant - Gopalpura
Solar Energy For Development
Scatec Solar
Development Alternatives

batteries cumbersome. They would like to have electricity in their homes.

The experience so far indicates that community mobilization is the key to the success of village electrification and it can be done only by people whom the villagers trust. It is easy to mobilize villages which consist of homogeneous community. Villages with different castes and trades pose challenge in social engineering. Moreover, providing light could give a temporary relief but very quickly, people's taste change and they aspire for more. A strong focus is on entertainment and most villagers would like to satisfy this need. Owning a colour television and a DVD player is a status symbol and villagers would like to flaunt it to establish their superiority over others. Needless to say, many families owned them even though there was no electricity in the village. Also, the ownership of the plant can be achieved by establishing an enterprise in the village and making it dependent on the electricity generated by the plant.

Future plans

Based on the Rampura and Gopalpura experience, the MNRE (Ministry of New and Renewable Energy) and Norad (Norwegian Agency for Development Cooperation) have funded a 30 village electrification model, adding to approximately 300 kWp. The project is managed by Scatec Solar and monitored by the IREDA (Indian Renewable Energy Development Agency). The objective of the project is to develop financial, technological, and operational models for the village electrification. Under the programme, a few non-governmental organizations have been identified who, in turn, have identified villages in Madhya Pradesh, Uttar Pradesh, Jharkhand, and Leh-Ladakh. The criteria of village selection are non-availability of grid power/unmet demand and potential of solar energy, either kick-starting a new income generation activity in the village or giving an impetus to the ongoing income generation activity. The villages and their loads have been identified.

Village mobilization, capacity building, and training are the integral parts of the programme. The various commercial activities being considered under the programme are Tsar reeling, irrigation, water services, horticulture, flour mill, butter churning, and so on. The programme is in the execution phase and the first phase, involving the installation and commissioning of solar PV plants, is expected to be completed by the middle of 2010. The key learnings of the programme will be shared with the funding agencies and recommendations for the financial and operational models will be made.

Conclusion

The development of villages is the key for reducing the congestion in big cities. It is possible only when opportunities are created in the villages. Availability of electricity in the villages enables the creation of opportunities in the villages. The demand of the villages is often not high enough to provide grid power to them. Decentralized solar power plants are ideally suited for village electrification. These plants are better-suited than giving subsidy on lantern from the point of view of control and monitoring. The Government of India has announced several schemes like feed-in tariff, capital subsidy, and accelerated distribution, and so on. In terms of its reach, distributed solar power plant has better reach, benefits a large population, and reduces the carbon footprint of India at the same time. Providing electricity to villages has a multiplier effect on the economy. The need of the hour is to evolve a robust financial and operational model for a mutually rewarding partnership between a private business entity and the government. In the incentive scheme, provisions have to be made for village mobilization and training to make the programme self sustaining and holistic.

INDO–US COOPERATION IN RENEWABLE ENERGY: DR STEVEN CHU MEETS DR FAROOQ ABDULLAH

The Secretary, U.S., Department of Energy, Dr. Steven Chu meeting the Union Minister of New and Renewable Energy, Dr. Farooq Abdullah, in New Delhi on November 14, 2009

Dr Steven Chu, Secretary, United States Department of Energy, met Dr Farooq Abdullah, Union Minister for New and Renewable Energy, on 14 November 2009. The meeting discussed various areas of cooperation in the field of renewable energy.

The two sides have agreed to take forward joint research and deployment of distributed generation, with focus on storage. It was agreed that, given the large potential in India in solar energy and the ambitious solar development plan being set out by the government, the two sides would collaborate both in encouraging investment and R&D (research and development) efforts.

It was also agreed that the biomass gassifier technology offers enormous potential to meet the energy requirement in rural areas. The two sides agreed to step up their R&D collaboration to develop small-size, biomass gassifiers, which can be made available for rapid deployment to meet the power needs in rural areas both in India and the United States.

INDIA'S FIRST MEGAWATT SIZE GRID-CONNECTED SOLAR POWER PLANT AT JAMURIA, WEST BENGAL

Country's first megawatt size grid-connected solar power plant has been inaugurated at Jamuria in the Asansol District of West Bengal. Dr Farooq Abdullah, Union Minister for New and Renewable Energy, said that the plant has already generated more than three lakh units of electricity in about three months. He said that two more plants of two-megawatt-capacity each have been set up in Karnataka at Kolar and Belgaum districts. They will add one more megawatt to both the plants very soon. One more plant of one megawatt will be set up in the Raichur District in Karnataka, Dr Abdullah added.

Dr Abdullah also announced that the MNRE (Ministry of New and Renewable Energy) has recently cleared proposals to set up another 28-megawatt-capacity solar plant in the country. He said that many private companies are preparing projects to set up more plants in the country.

SUNNY EMPOWERMENT TO REMOTE COMMUNITY SERVICE CENTRES

VIVEK ADHIA, Sr Consultant, and **DR SANJAY MANDE,** Manager, DTTIPL (Deloitte Touch Tohamatsu India Pvt. Ltd), Gurgaon

The NeGP (National e-Governance Plan) is part of the National Common Minimum Programme, which was set up with an aim of facilitating information and government services to the doorsteps of its citizens. Under this plan, the Ministry of Information Technology, Government of India, proposes the implementation of a network of more than 100 000 Internet- and ICT (Information and Communication Technology)-enabled access points, termed as CSCs (Common Service Centers). It would cover at least 5–7 villages under every Panchayat of the country. The larger objective is to reach out to the entire rural mass of India.

Objectives

- To facilitate rural development.
- Use of RE (renewable energy) technologies to meet the decentralized off-grid power requirements in a sustainable manner.
- Use of CDM–PoA (Clean Development Mechanism–Programme of Activities) as a tool to partly mitigate the implementation and investment barriers towards setting up of CSCs based on RE and encouraging PPP (Public-Private Partnerships).

Using renewables...

The major roadblock for the implementation of this initiative is that there is no consistent source of power/electricity in these remote locations and the local villagers keep relying on the traditional means such as fire wood. However, these sources of energy are in no way sufficient to power the high technology ICT centres. Use of DG (diesel generator) sets, too, is not a suitable option because of the environmental concerns.

Thus, it was decided to tap the potential of RE technologies to ensure a consistent and sustainable means of decentralized off-grid source of power. Solar-based PV (photovoltaic) systems are deployed across all CSCs. Modules of 75/150/300 watt peak, procured on a mass scale, are coupled up with each of the CSCs as a major source of power. By using the solar PV-based technology, Zoom contributes significantly towards environmental sustainability and ensures a clean and renewable source of power to the CSCs.

Considering that the project activity contributes significantly towards sustainable development in the region, there is a potential to set up such CSCs by utilizing the carbon credit revenues associated with the project and part mitigate the implementation barriers.

...And carbon credits

To evaluate the possibilities of utilizing carbon benefits, a leading professional services firm, Deloitte Touche Tohmatsu India Pvt. Ltd, is currently in the process of developing a structural framework for the utilization of CDM–PoA. A CDM–PoA is considered to be a voluntarily coordinated action by a private or a public entity, which coordinates and implements any policy/measure or a stated goal, which leads to GHG emission reductions or increase in the net GHG removals by sinks.

The initiative commissioned by the BHC (British High Commission), New Delhi, is part of the overall strategy of the United Kingdom Department for International Development for facilitating sustainable development in emerging economies. The BHC, in association with the representatives from the MNRE (Ministry of New and Renewable Energy), IITD (Indian Institute of Technology Delhi), and Deloitte, has selected a case study for further development. As a model case, Zoom Developers Pvt. Ltd has envisaged implementation and operation of CSCs in the state of Jharkhand.

Table 1 Estimate of CERs

Timelines	Number of CSCs planned	Emission reductions estimated (CERs)
Year 1	2 000	1 108
Year 2	4 000	2 216
Year 3	8 000	4 432
Year 5	12 000	6 648
Year 6	16 000	8 864
Cumulative	**42 000**	**23 268**

The project

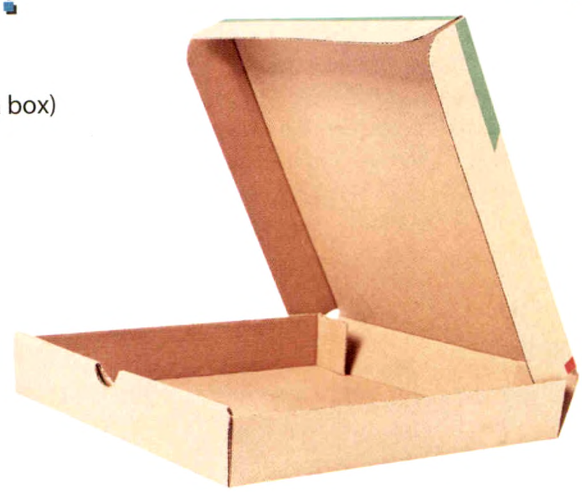
Zoom Developers Pvt. Ltd has planned the implementation of CSCs in Dumka, Devghar, Pakhur, Jamtara, Shaibganj, and Godda districts in Jharkhand. Under the programme, Zoom plans to roll out 1500 CSCs within the next 8–10 months in the state of Jharkhand. If the model is proved successful and operationally viable, Zoom envisages setting up of approximately 42 000 CSCs across eight states of India, within the next 4–5 years.

While physical implementation of the project is being planned out, the development of CDM PoA documentation and related activities is under full swing. The subject matter experts at Deloitte, along with Zoom executives, have visited the proposed locations and carried out detailed stakeholder consultations. The project documentation has been developed and submitted for host country approval.

Way forward

It can thus be concluded that implementation of CSCs can bring about a significant change in the rural landscape of the country, reflecting an increased boost to sustainable development. The major challenges/barriers towards the implementation can be taken care of by harnessing the potential of RE technologies and the use of CDM–PoA as a tool, encouraging private sector participation.

WANT TO MAKE A SIMPLE SOLAR OVEN AT HOME? IF YES, THEN READ ON!



You need

1. One cardboard box (shoe box or pizza box)
2. Newspapers
3. Black construction paper
4. Clear plastic wrap
5. Aluminum foil
6. A rectangular piece of paper
7. A pencil
8. Glue and tape
9. Scissors
10. A ruler or stick

You build

- Make sure the cardboard is folded in its box shape and closed.
- Place the piece of paper in the centre of the lid of the box and trace its outline on the lid.
- Carefully cut the two long edges and one of the short edges of the traced rectangle, forming a flap of cardboard.
- Gently fold the flap back along the uncut edge to form a crease.
- Glue the underside (inside) face of this flap with aluminum foil. The foil will help to reflect the sunlight into the box.
- Place a piece of the black construction paper inside the box. The fitted paper will help to absorb the Sun's heat.
- Roll up some newspaper and fit it around the inside edges of the box. It should be about 1 to 1.5 inches thick. Use tape to hold the newspaper in place, but only tape it to the bottom of the box, not the lid.
- Cut two pieces of plastic wrap an inch larger than the flap opening on the box top. Open the box and tape one piece of the plastic wrap to the underside of the flap opening.
- Close the box and tape the other piece of the plastic wrap tightly to the top of the flap opening. This creates a layer of air as insulation that helps keep the Sun's heat in the box.

And it is ready!

Open the box, put the food in the centre, and close the box. Now open the flap and turn the box so that the foil faces the Sun. The shadow of the flap should go straight back from the back of the box. Use a stick to prop up the flap so that it bounces the sunlight into the box. And soon, you can enjoy your warmed-up food!

Send in your answers to the following address. The first three correct entries will be published in the next issue of *Akshay Urja*.

The Editor, *Akshay Urja*
Room No. 1009A, 10th Floor, Paryavaran Bhavan, CGO Complex
Lodhi Road, New Delhi – 110 003
E-mail aktripathi@nic.in or suparna.mukherji@teri.res.in

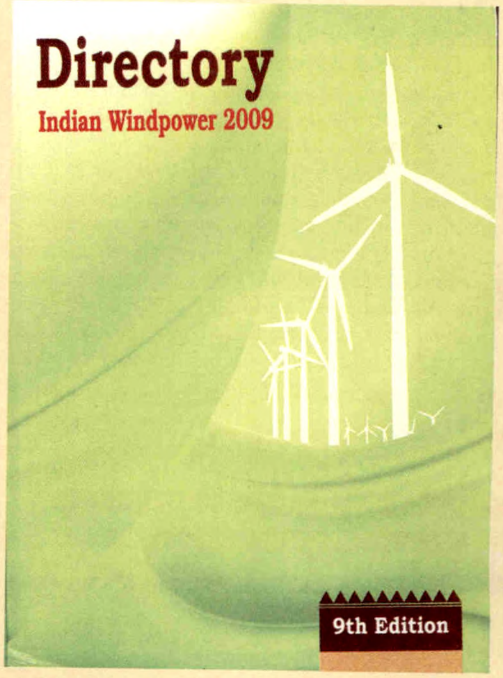
DIRECTORY INDIAN WIND POWER 2009

With the prime objective of providing the basic guidelines to the entrepreneurs interested in wind power project – a comparatively new and environment-friendly source of energy – Consolidated Energy Consultants Ltd took lead in consolidating wind related data/details and publishing an encyclopedia-like book. Since its maiden publication in 2001, the Directory Indian Wind Power has earned wide acclamation from both the government departments as well as the industries for its comprehensive coverage and reliability of data.

The current edition, similar to the previous eight yearly issues, carries the usual features. However, the new edition is loaded with a comprehensive data on wind potential sites in the various states of India, the government's promotional policies, incentives offered by the states/central government, supportive role of C-WET (Center for Wind Energy Technology), the technical particulars of the wind electric generator, and the current scenario in wind power development. All this information is presented in well-structured sections of over 850 pages for ease of access.

As a regular coverage, it also includes the capacity additions over the years, the present installed capacity by states vis-à-vis the technical potential available, the estimated power generation, the cost economics, guidelines on the Clean Development Mechanism, the relevance of the Electricity Act 2003 for wind power projects, and the trend of year to year variation in wind speed and the consequential generation by the operational wind farms.

It provides encyclopedic information on the wind farms in India and the details about the various stakeholders, including manufacturers, developers, financial institutions, state nodal agencies, societies and associations, component suppliers, and service providers like erection contractors/O&M (operations and maintenance) agencies/repairers/crane hiring agencies, and others, compiled with more than 2500 entries. Procedural steps for establishment of wind farms, Indian Wind Turbine Certification System, insurance, and guidelines for diversion of forest land for wind power projects are some of the related subjects that have also been touched upon in the Directory. The broad perspective adopted for the Directory is evident from the inclusion of frontline topics like hybrid systems, using diesel and solar energy with wind power and water pumping wind mills. It also focuses on the current technological trends and worldwide development of the wind power sector. An attempt has also been made to include a list of publications on related subjects as well the connected websites.



DIRECTORY INDIAN WIND POWER 2009
Madhya Pradesh: Consolidated Energy Consultants Ltd
850 pp. • Price: Rs 1500 (including packaging and forwarding)

In a nutshell, the Directory Indian Wind Power 2009 would serve as an indispensable reference book for all individuals and agencies directly or indirectly connected with the development of this new and promising energy sector.

Reviewed by ***Suparna Mukherji****, TERI Press*

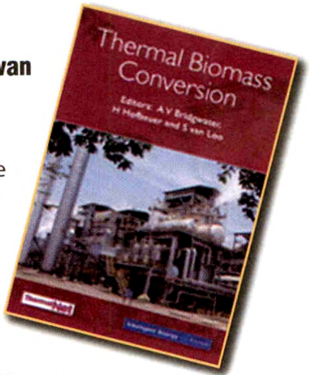
COVERAGE IN GENERAL

Wind power development • Government organizations, guidelines, incentives, policies, and addresses • Wind resource assessment • Cost economics • Wind power installations • Wind farm owners and developers • WEG (wind electric generator) manufacturers and technical particulars • Components/spares, tools, and lubricants suppliers • Service providers • Financial institutions • Associations, societies, and institutions • Water pumping windmills, wind battery chargers, and wind hybrid systems • Worldwide wind power development and services • Miscellaneous

THERMAL BIOMASS CONVERSION

Edited by AV Bridgwater, H Hofbauer, and S van Loo.2009

CPL Press


Thermal Biomass Conversion
Editors: AV Bridgwater, H Hofbauer and S van Loo

This book presents the final report from the ThermalNet network, the latest thermal biomass conversion network to be carried out on a European basis. In addition to continuing work of earlier networks on pyrolysis and later pyrolysis and gasification, ThermalNet included combustion and hence, covered all thermal biomass conversion technologies.

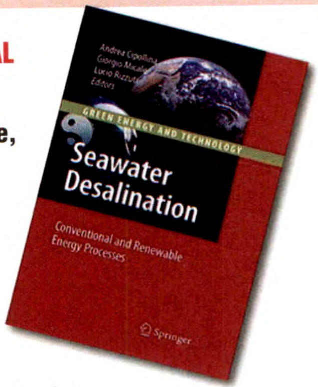
The project was funded by the EACI (European Commission Executive Agency for Competitiveness and Innovation) through the Intelligent Energy Europe Programme, with contributions from IEA (International Energy Agency) Bioenergy on the pyrolysis theme and extensive interactions in all areas with the relevant IEA Bioenergy Tasks 32, 33, and 34. The overall goal was to establish a comprehensive trans-European forum on thermal biomass conversion that covered all the technical, economic, market, environmental, and policy issues that require consideration for the establishment of a successful European thermal bio-energy industry.

ISBN: 978-1-872-69153-4 • Price: £125.00

SEAWATER DESALINATION: CONVENTIONAL AND RENEWABLE ENERGY PROCESSES

Edited by Andrea Cipollina, Giorgio Micale, and Lucio Rizzuti.2009

Springer



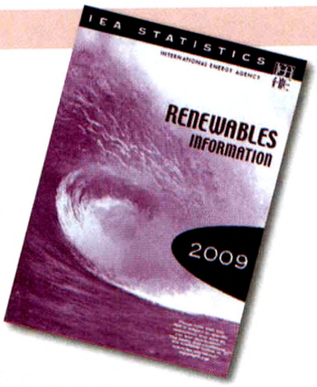
A growing proportion of the world's population is dependent on seawater desalination as a source of fresh water for both potable and civil use. One of the main drawbacks of conventional desalination technologies is the substantial energy requirement, which is facing cost increases in the global energy market. Seawater Desalination presents an overview of conventional and non-conventional technologies, with a particular focus on the coupling of renewable energies with desalination processes. A rapid growth in these technologies is foreseen in the coming years. This book provides a unique foundation, within the context of present and future sustainability, for professionals, technicians, managers, and private and public institutions operating in the area of fresh water supply.

ISBN: 978-3-642-01149-8 • Price: €129.95

RENEWABLES INFORMATION 2009

International Energy Agency

IEA/OECD

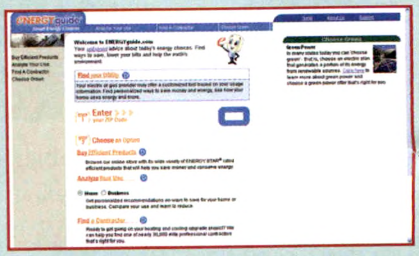


Renewables Information 2009 provides a comprehensive review of the historical and current market trends in OECD (Organisation for Economic Co-operation and Development) countries. It brings together essential statistics on renewable and waste energy sources. It, therefore, provides a strong foundation for policy and market analysis, which can better inform the policy decision process to select policy instruments best suited to meet domestic and international objectives. It is one of a series of annual IEA (International Energy Agency) statistical publications on major energy sources; other reports are Electricity Information, Natural Gas Information, Oil Information and Coal Information.

ISBN: 978-92-64-06114-9 • Price: €110

Internet resources

ENERGYguide.com

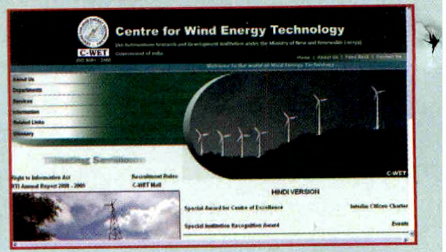


www.energyguide.com

ENERGYguide.com is an unbiased guide to the myriad of energy options that are available to the people. You can learn how to lower your energy bills by replacing equipment in your home or business, changing the way you use energy, or selecting a different electric or gas supplier (United States-specific). You will also learn how your choices impact the environment.

The website is affiliated to the Energy Star programme of the Environmental Protection Agency, United States. Energy Star certification is awarded to the products that meet a threshold of energy efficiency. And many of these products can be ordered through the website. ENERGYguide.com has earned both Better Business Bureau On-Line and Trust-e certification, attesting privacy security.

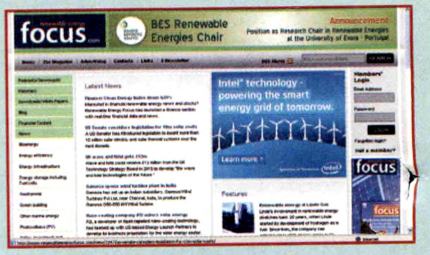
Centre for Wind Energy Technology



www.cwet.tn.nic.in

C-WET (Centre for Wind Energy Technology) is an autonomous research and development institution under the MNRE (Ministry of New and Renewable Energy). It is a knowledge-based institution of high quality and dedication, offers services and seeks to find complete solutions for the kinds of difficulties and improvements in the entire spectrum of the wind energy sector by carrying out further research. And its knowledge-bank is presented in the website. It provides a wide range of information—from the basics of the wind sector in India to case studies and projects.

Renewable energy focus


focus
BES Renewable Energies Chair
Latest News
Intel technology powering the smart energy grid of tomorrow.
Learn more
focus

www.renewableenergyfocus.com

The website is a storehouse of information related to renewable energy. It provides news, write-ups, blogs, webinars, and so on. It covers all aspects of bioenergy; energy efficiency, infrastructure, and storage; geothermal; green building; marine energy; photovoltaics; policy, investment, and markets; solar electricity; solar heating and cooling; wave and tidal energy; wind power; and so on.

Renewable Energy
Akshay Urja

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The views expressed by authors including those of the editor in this newsletter are not necessarily the views of the MNRE.

FROM THE EDITOR'S DESK

Dear Reader,

Energy is a key indicator and input to the social, economic, industrial, and technological development of a country. Human's quest for leading a better and comfortable life has compelled him to use all available energy sources, irrespective of the involved cost and environmental degradation. In the present era of massive growth in all spheres of life, which is increasing the energy demand manifolds, the use of all available resources is a must. And renewable energy cannot be ruled out. It is rather emerging as an alternative to conventional fuels.

Everything in this world moves because of energy. The standard of living of a country can be directly related to its per capita energy consumption. Energy plays a major role in the development of a country. Its growth is measured in terms of technological development, industrialization, economical growth, and so on. Today, Japan, US, Germany, and UK are called developed countries due to their advanced technological development, rapid industrialization, and energy production and consumption.

India is poised to gain a high growth rate, and thus, its energy demand is increasing exponentially. Renewable energy is now contributing towards fulfilling the ever-increasing energy demand in the country. The country is, thus, focussing on the growth of renewable energy. Among others, biofuel or biodiesel has a promising future due to its natural availability, 99.9% resemblance with diesel, and versatile applications in all machineries, transport, generator sets, and other such places where diesel is used.

Biodiesel, the renewable liquid fuel produced from biological raw material, is a good substitute for petroleum diesel. It is gaining worldwide acceptance as an environment-friendly solution to the energy problem. The production of oil-producing crops is a major challenge when most of the cultivable area has been occupied by conventional/cultivated crops. So, plant species that can come up in degraded lands need to be promoted. Although a biofuel policy has been announced, it is yet to take off in the country.

The present issue in your hand provides informative material in biofuel areas, that is biodiesel production from non-edible oil of Assam; biomass, biofuel, and food security; and bio-hydrogen production technology. The efforts are also on for generating electricity through algae cells, as presented in the 'RE Tech Update'. Refrigeration using solar energy is also an upcoming field and has a lot of scope for those places where electricity is yet to reach. This aspect has been presented in two other articles.

I am sure that you will find this issue informative and interesting. Do send us your valuable suggestions to make *Akshay Urja* more interesting and useful.

Happy reading!

ARUN K TRIPATHI
<aktripathi@nic.in>

Published, printed, and edited for and on behalf of the Ministry of New and Renewable Energy, Government of India, from B-14, CGO Complex, Lodhi Road, New Delhi, by Dr Arun Kumar Tripathi. Printed at M/s Brijbasi Art Press Ltd, E46/11, Okhla Industrial Area, Phase II, New Delhi – 110 020, India

Since the last three years, my child has been giving me his environmental studies book to read out to him. I realized then that India, as a developing nation, has to balance our eco system. So now I am trying to open a small business of solar products, which would somewhat, if not fully, reduce the load on electricity generated by polluted means. I would be marketing as well as spreading awareness about solar energy and other energy saving products. Last week, I chanced upon *Akshay Urja*, Ministry of New and Renewable Energy's bimonthly magazine, and I am thoroughly impressed and humbled by the enormous amount of useful information in it, which can be used as a guiding tool for people like us.

Krishna M Pamidi
83, off. C H Street,
Near Marine Lines flyover,
Mumbai–400 002

You have been kind enough to send a complimentary copy of *Akshay Urja* Volume 3 Issue 1 August 2009 issue for the use of our studious students, brilliant faculty, tireless researchers, and dedicated professionals in the pursuit of their curriculum and research activities.

Since your bi-monthly newsletter is very useful and relevant to our clientele, kindly continue its supply to us by including our name in your mailing list. In case some issues of volume 2 are still available, please mail them to us.

Pravin Naidu
75, Kalpataru Housing Society,
Om Nagar, Kalmana Road, near new water tank,
Ranala (G P), Kamptee, Dist.
Nagpur–441002

I have been working as the Director and Chief Executive Officer of TREDA (Tripura Renewable Energy Development Agency) for more than three years. And I am deeply impressed by the publications of MNRE's (Ministry of New and Renewable Energy) newsletter *Akshay Urja*, under the leadership of Dr A K Tripathi, Director, MNRE. The editorial written by Dr Tripathi in the last issue has given me deep thoughts which are valuable.

I have developed a keen interest in the different programmes of the MNRE on NCES (non-conventional energy sources) and up-to-date achievements, future programmes, and so on. In fact, I want to be associated with the development of renewable energy sources in India and abroad, even when I shall not be working in TREDA in the future.

Subhash Chowdhury
Director and CEO, TREDA

नवीन और नवीकरणीय ऊर्जा मंत्रालय, नई दिल्ली के ओर से निकलने वाले अक्षय ऊर्जा द्विमासिक अंक से मैं प्रभावित हूं। मैं महाराष्ट्र राज्य के कोल्हापुर जिले के नांहणी गांव में रहता हूं। मैं एक किसान हूं और मेरे गांव में इस पत्रिका के आने से सौर ऊर्जा, पवन ऊर्जा, जैविक ऊर्जा के क्षेत्र में मंत्रालय द्वारा नई–नई योजनाएं, उससे मिलने वाले लाभ और ऊर्जा के बारे में नए नए शोध, उपाय और मिलने वाले स्थान और ऊर्जा के बारे में होने वाले नियमों, शर्तों आदि के बारे में पूरी जानकारी मिलेगी और उसका लाभ लेने वाले सभी लोगों को होगा। आप हमें इस पत्रिका का द्विमासिक अंक हिंदी भाषा में मुझे नीचे दिए हुए पते पर भेजने की कृपा करें।

यदि इसके पहले दो बरसों से निकले हुए सभी अंक आपके पास उपलब्ध हो सकें तो उन्हें भी भेजने की कृपा करें।

महावीर आफासो पाटील
मु. पो नांहणी, तालुका शिरोक
जिला कोल्हापुर, महाराष्ट्र

I am a professor of Mechanical Engineering in AVIT (Aarupadai Veedu Institute of Technology). I have gone through your newsletter, *Akshay Urja*, and found it interesting and informative. The reading of this news bulletin is very much necessary for the engineering student community. The faculty and students enhance their knowledge by reading *Akshay Urja*.

Prof. K V Krishna Sastry
Professor and Head of Department,
Mechanical Engineering Department,
AVIT, Vinayaka Missions University,
Chennai

Indian Railways Institute of Electrical Engineering is a centralized training institute under the Ministry of Railways, Government of India, which imparts training to the electrical department officers of the Indian Railways.

Your esteemed publication titled *Akshay Urja* is being received regularly. The readers/members of this institute have got immense benefit out of the articles published in the magazine. It is very useful for project work, research study, and provides latest technical know-how and information on current affairs related to various aspects. It is preserved carefully in our library for future use as reference to be used by the trainee officers of the Indian Railways and others.

P K Badhyopadhyay
Librarian/Assistant Librarian and
Information Officer, Indian Railways
Institute of Electrical Engineering
Nasik Road, Maharashtra—422101

Dear Reader,

Thank you very much for your encouragement. The editorial team of *Akshay Urja* will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvement in terms of content and presentation.

Editor
Akshay Urja

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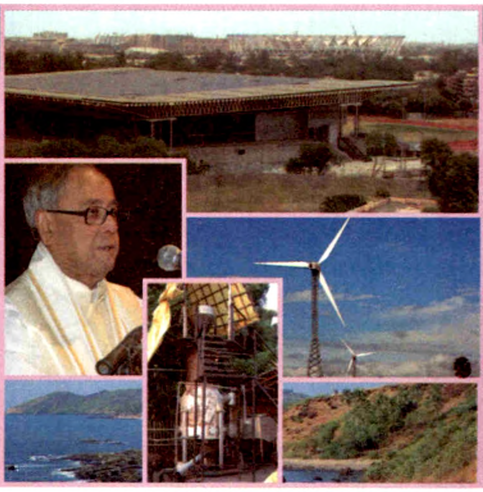

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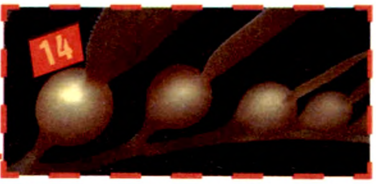

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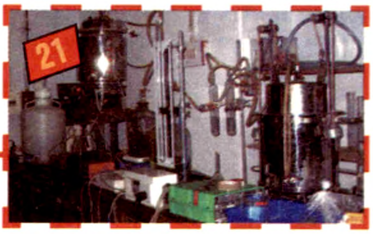

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Telcos should come forward in utilization of renewable energy, says Dr Abdullah

Dr Farooq Abdullah, Union Minister for New and Renewable Energy, highlighted the need for the utilization of renewable energy by telecom players for their towers and urged that industry should come forward in doing so. Dr Abdullah was speaking at a seminar organized by the CMAI (Communications and Manufacturing Association of India).

Green solutions to power-related problems for rural telephony and changing the economics of backup power were discussed at the round table, inaugurated by A Raja, Union Minister of Communication and Information Technology, and Dr Farooq Abdullah, Union Minister of New and Renewable Energy, in the presence of Venugopal Dhoot, Chairman, CMAI. Currently, the total carbon emission from cell phone towers in India is 5.3 million tones, annually. The annual cost of diesel, incurred on running the towers across India, is estimated at Rs 6400 crores. These facts highlight the growing need to promote the adoption of renewable energy options for the telecom sector in India. Alternative energy options, including solar and wind energy, can address the challenge of unavailability of reliable power supply in semi-urban, rural, and remote areas, enabling telecom connectivity for the remote parts of the country.

Dr Abdullah and A Raja also launched the publication Role of Renewable Energy in Telecom by CMAI's knowledge partner Mazars. The publication highlights the utility of renewable energy and other related technological innovations in the telecom sector, while also identifying advantages of alternative sources of energy and their impact on reducing costs of running the network critical equipment.

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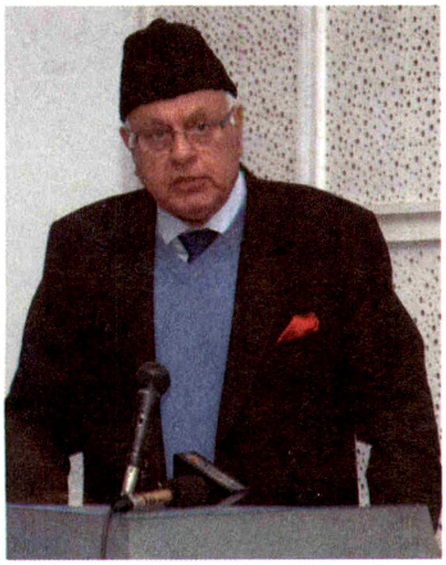


Commonwealth games 2010 to be solar powered by Reliance

The solar energy initiative of RIL (Reliance Industries Ltd), RIL Solar Group, has successfully implemented and commissioned India's first 1 MW (megawatt) solar plant on the roof of Thyagaraj Stadium in New Delhi. The Thyagaraj Stadium, developed by the Government of Delhi, is planned to be a model green stadium. RIL Solar Group has also implemented power plants in the R K Khanna Tennis Complex and solar LED (light-emitting diode) streetlights and garden lights in the Commonwealth Games Village. With these, the RIL Solar Group has installed 100% of the solar PV (photovoltaic) power generating equipment for the Commonwealth Games 2010. The entire solar initiative is one of the major initiatives to compensate for the CO_2 (carbon dioxide) to be emitted during the Game.

Installed and commissioned in a record duration of less than three months, the power plant is expected to generate around 1.4 million units of electricity per year. It would cater to the power requirements of the stadium and the surplus would be fed to the grid at 11 KV (kilovolt). The solar power generated through 1 MW solar PV power plant at the stadium is expected to result in emissions reduction of more than 1200 tonnes of CO_2 per year.

The Group has also implemented three 2.6 KWp (kilowatt peak) solar PV power plants on the roof of individual tennis courts in the R K Khanna Tennis Complex. Further, there are 34 back-up solar PV systems of 3 KWp each, along with 180 solar LED street lights and 500 garden lights in the Commonwealth Games Village.

Commenting on the achievement, Mukesh Ambani, Chairman and Managing Director of RIL, said, 'We have always believed that the renewable energy space is a natural extension

of our strengths in the conventional energy platform. The nature of technical expertise and project execution demonstrated in developing the solar power infrastructure is a defining achievement for our solar group. We will continue our efforts in research, understanding, and scaling up the deployment of these environment-friendly sources of energy. RIL is privileged and honoured to work with the Government of Delhi and the Organizing Committee, and be an integral 'green' part of a showcase event like the Commonwealth Games 2010.'

RELIANCE INDUSTRIES LTD

Ladakh renewable energy initiative

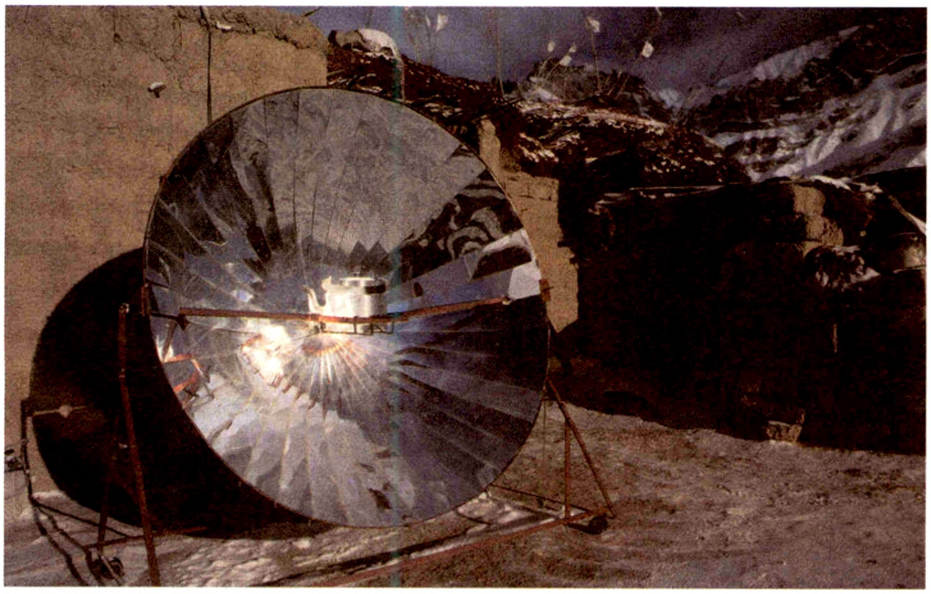
The Cabinet Committee on Infrastructure has approved a project to promote the use of renewable energy in the Ladakh region at a total cost of Rs 473 crore. The Ladakh region has extreme environment conditions and faces enormous energy adversities throughout the year. It becomes even more acute during the winter months. The urban areas and all defence establishments use diesel and kerosene extensively. The population in the remote areas faces acute shortage of fuel for cooking and space heating. Considering that the region has a good potential of solar and hydro resources, much of it can be realized and effectively used for minimizing the use of diesel, kerosene, and fuelwood.

Detailed studies were undertaken in the Leh and Kargil districts of the region and after consultations with all the stakeholders, including defence officials, Ladakh councils in Leh and Kargil, districts officials, NGOs (non-governmental organizations), and others, the MNRE (Ministry of New and Renewable Energy) has prepared a plan for the large-scale use of renewable energy with a total financial requirement of Rs 473 crore.

The plan envisages 30 small/ micro hydel projects, aggregating to 23.5 MW (megawatt) capacity; setting up of about 300 SPV (solar photovoltaic) power plants of 5–100 KW capacity; 2000 SPV home lighting systems; and about 40 000 solar thermal systems like water heaters, solar cookers, solar passive buildings, solar green house, and so on. The solar greenhouses proposed to be set up in the region would help in increasing the production of green vegetables in winters for the region, which are otherwise procured from far off places.

The implementation of the Plan will start from June 2010 and will be completed by December 2013. The renewable energy projects are expected to result in a saving of about 200 lakh litres of diesel per year.

MNRE



Biomass gasifier systems in rice mills to substitute diesel

In view of the enormous potential for saving fossil fuels, specifically diesel which is presently being used in rice mills for meeting their captive power requirements, the MNRE (Ministry of New and Renewable Energy) has recently launched a new scheme for promoting rice husk-based biomass gasifier systems. These systems would not only save diesel but will also provide cost-effective reliable solution for their captive power requirements, using the rice husk produced in rice mills.

In order to facilitate the rice mills to avail the special financial package expeditiously, a MoU (Memorandum of Understanding) has been signed between the State Bank of India, Patna, and M/s Beltron Telecommunication Ltd, Patna. Through this technical and financial mechanism, about 500 rice mills would be able to avail the benefit by setting up biomass gasifier systems during 2010, which will lead to the saving of about 20–25 million litres of diesel annually and at the same time, provide the benefits of a reliable power supply.

PRESS INFORMATION BUREAU

MNRE constitutes core group to assess status of improved biomass cookstoves

In order to make smokeless stoves popular, the MNRE (Ministry of New and Renewable Energy) launched a National Biomass Cookstove Initiative in 2009. The primary aim of the initiative is to develop and enhance the availability of better and efficient family- and community-size biomass cookstoves for household and industrial applications in the country. It also emphasizes the enhancement of technical capacity in the country by setting up testing, certification, and monitoring facilities and strengthening R&D (research and development) programmes in various technical institutions of the country. In this regard, the MNRE has constituted a core group and sanctioned a project to assess present status of various types of improved biomass cookstoves currently available, their suitability, and delivery mechanisms, and to prepare an action plan for the development and deployment of cookstoves. Simultaneously, the MNRE has identified four test centres for carrying out the performance testing.

PRESS INFORMATION BUREAU

Efforts initiated to develop biofuel, says Dr Abdullah

Dr Farooq Abdullah, Union Minister for New and Renewable Energy, recently announced that efforts have been initiated to develop coordinated R&D (research and development) projects on second generation biofuels, such as production of ethanol from agricultural wastes/residues and biodiesel from algae.

He also said that the National Policy on Biofuels is aimed at accelerated promotion and development of biofuels like bioethanol and biodiesel. The OMCs (oil marketing companies) have been directed to sell 5% ethanol-blended petrol in the entire country, except northeastern states, Jammu and Kashmir, Andaman and Nicobar Islands, and Lakshdweep. Biodiesel is currently not being marketed commercially for blending with diesel, as the biodiesel industry is still at a nascent stage of development. R&D is also being pursued through different scientific agencies on feedstock development, conversion processes, and production of ethanol, mainly from sugarcane molasses and biodiesel from jatropha.

The Minister further informed that the amount spent by the various ministries/departments during the last three years from 2006/07 to 2008/09 is about Rs 48.98 crores, and is Rs 20.37 crores so far during the current year.

PRESS INFORMATION BUREAU

Areva, Siemens, GE explore offshore wind-ow in India

A long coastline, low installation cost, and ready local availability of key raw materials have made India a favoured destination for offshore wind power, with global majors like Areva, Siemens, and GE (General Electric) queuing up to explore opportunities in the country.

'Offshore wind is the new growth area and has immense opportunities in India due to cheaper costs,' Areva Renewables global Chief Executive Officer Anil Srivastava told Economic Times. 'Faster project building time and lower costs will make it an attractive option in India,' he said, adding that his company was currently studying the possibilities for such a venture in India.

Areva, the world's largest nuclear plant builder, has already built 600 megawatts of offshore wind projects in Europe and has estimated that installation costs in India could be 30%–40% less than that in Europe, where it is about $2.2 for every megawatt of offshore wind built.

Like Areva, other majors such as Siemens and GE have also been exploring similar opportunities in the country. Cheaper tariffs will be the driving force for building offshore wind projects, as prices of electricity are expected to grow due to tight coal supplies and surging demand. Spot rates for electricity have more than doubled to about Rs 10 per kilowatt hour, as compared to Rs 4 of last year.

Typically, in offshore wind projects, a large part of the offshore area will be offered to developers, who will build minimum of 200–400 MW (megawatt) of wind power projects. Each such project will have a height of over 80 metres, using about 600–900 tonnes of high-grade steel, which can be sourced locally.

Since offshore wind projects can be built close to big consumption centres that are typically located in coastal areas, the long western coastline will suit such a model, mainly as most large industries are situated along the country's western coast.

THE ECONOMIC TIMES

Coal tax to pay for new renewable energy fund

The Indian government is expected to back up its recent commitment to curb carbon emissions with a controversial move to levy a new tax on coal in order to pay for the roll out of renewable energy technologies.

Indian finance minister Pranab Mukherjee said that a clean energy tax of Rs 50 per tonne will be levied on all domestically produced or imported coal, with the resulting revenue ring-fenced for use in a new national renewable energy fund.

'Harnessing renewable energy sources to reduce dependence on fossil fuels is now recognized as a credible strategy for combating global warming and climate change,' he said. He also set out a range of tax breaks designed to accelerate the roll out of solar, wind, and geothermal technologies. In particular, solar equipment, some wind turbine parts, and electric vehicles will be exempted from a production tax on new goods, while heat pump systems will be exempted from import duties, and equipment used in solar power plants will be granted a power import tax rate of just 5%.

The announcement also provided a boost to some of India's leading clean-tech firms, with wind turbine manufacturer Suzlon Energy and solar specialist Moser Baer India seeing their share prices climb 5% and 7.4%, respectively.

The government did not provide details of how much money it expected to raise through the new coal tax, but it is estimated that about Rs 25 billion a year could be generated for investment in renewables.

WWW.BUSINESSGREEN.COM

India can produce up to 200 000 MW wind power

The wind energy sector is emerging as an important segment in the global renewable energy map and countries like India and China are expected to become leaders in the future. The total potential for wind power in India is expected to be much more than the government estimate of 45 000 MW and the industry places it at a high 200 000 MW.

'India has a potential of 70 000 MW of wind power and this can be reassessed up to 200 000 MW by resourcing new wind areas and re-powering through larger and latest technology turbines,' says D V Giri, Chairman, IWTMA (Indian Wind Turbine Manufacturers Association). The total potential for wind power in India was first estimated at 45 000 MW by the C-WET (Centre for Wind Energy Technology). This figure

was adopted by the government as the official estimate following a comprehensive wind mapping exercise by the MNRE (Ministry of New and Renewable Energy), which established a countrywide network of 553 wind-monitoring stations in 25 Indian states.

However, those wind measurements were carried out at lower hub heights of 50–60 m. Hence, IWTMA estimates that the potential for wind development in India is much higher than the past estimates by reassessing at higher hub heights. 'Compared to the United States and Europe, which are still growing in wind capacity addition, India and China have very large land mass and huge demand potential for electricity, as still hundreds of villages in the country are yet to be electrified,' said Giri. With several new support initiatives, India is hoping to add 2500 MW capacity in 2010/11 and reach up to an annual capacity addition of 5000 MW by 2015.

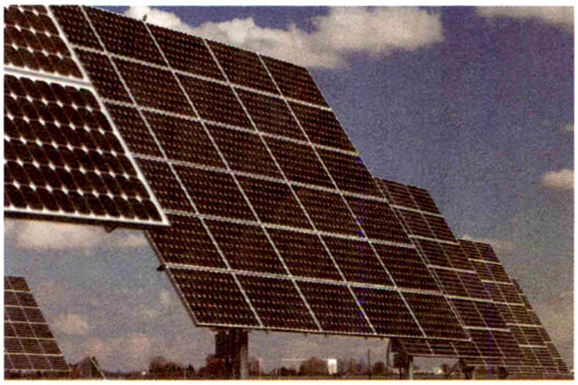
WWW.MYDIGITALFC.COM

UAE firm in $545 million deal with Aditya Solar Power

UAE-based (United Arab Emirates-based) company Mulk Holding has announced an agreement with Bangalore-based Aditya Solar Power Industries to develop a 200 MW (megawatt) solar thermal project in the UAE. The holding company said one of its subsidiaries, Mulk Renewable Energy, will supply and install solar thermal power plants for Aditya Solar in a deal valued at $545 million.

According to the agreement, Mulk Renewable Energy will create a joint venture with Aditya Solar to develop the project. 'The project will be implemented in two phases. Phase one will see the execution of a 40 MW plant by 2012 and the balance of 160 MW by 2013,' said the company in a statement. Mulk Renewable Energy will have a 25% equity stake in the first 40 MW. 'Major components will be manufactured in the UAE and exported to India for the initial phase and a full-fledged manufacturing facility of 500 MW capacity will be established in India for the next phases,' it added.

THE ECONOMIC TIMES



Punjab mulls to generate 1000 MW power in collaboration with Sunpower and EBS

In a bid to tap optimum potential of solar energy in Punjab, the state government has decided to set up a chain of solar power plants in collaboration with US-based (United States-based) SunPower Corporation and EBS (Enterprise Business Solutions) for generating about 1000 MW (megawatt) power in a phased manner over the next two years.

A decision to this effect was taken at a high-level meeting with the joint delegation of SunPower Corporation and EBS and the Chief Minister of Punjab, Parkash Singh Badal. The minister has directed Viswajeet Khanna, Secretary, Science and Technology, to prepare a comprehensive plan to establish a network of solar power plants in the state in collaboration with SunPower and EBS through PEDA (Punjab Energy Development Agency). He has also asked the representatives of SunPower and EBS to set up demo projects at the rooftops of the government buildings for tapping solar energy, which could be later replicated in other government buildings such as the district administrative complexes, warehousing, and Markfed godowns. Badal also gave in-principle approval to the proposal mooted by the SunPower-EBS group to set up a centre for training

the youth in solar technologies at the PEDA complex.

WWW.PUNJABNEWSLINE.COM

Punj Lloyd bags Rs 232 crore order from Bihar Government

Punj Lloyd has bagged India's largest solar-based EPC (engineering, procurement, and construction) contract of Rs 232 crores from the Public Health and Engineering Department of Government of Bihar. The scope of work includes design, construction, and commissioning of 850 solar-powered water treatment plants across the state of Bihar. The solar water treatment plants designed and constructed by Punj Lloyd will resolve severe groundwater contamination.

The contract will be executed by Punj Lloyd's renewable energy arm, Punj Lloyd Delta Renewables. The combined solar power generation for these plants will be greater than 1.3 megawatt. Punj Lloyd Delta Renewables provides cutting-edge technology in turnkey-integrated development and sustainable solutions based on solar power. With this contract, the order backlog for Punj Lloyd group on consolidated basis has gone up to Rs 26 205 crores.

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BUSINESS STANDARD

Harvesting solar energy in Rangilu, Rajkot

In a significant move towards developing Rajkot as a Solar city, Rajkot Municipal Corporation (RMC) is going to set up 200 kilowatt-peak (kWp) grid-connected solar photovoltaic (PV) system power station within the next six months. According to senior RMC officials, the system will be implemented in a phased manner initially—a 100 kWp system will come up in the city's west zone by 15 August, followed by the second half in the next six months. RMC plans to inaugurate the 100 kWp station during the Independence Day celebrations.

THE TIMES OF INDIA

Tele towers face switch to solar power for back-ups

The government may ask telecom companies to install solar panels to generate backup power for cellphone towers. A proposal being finalized by the MNRE (Ministry of New and Renewable Energy) is aimed at containing the use of polluting diesel generator sets to provide back-up power.

The green drive will prevent these engines of development (telecom towers) from becoming grave environmental hazards. The MNRE is discussing the proposal with various stakeholders. A cabinet note is proposed to be finalized thereafter to get the clearance for the scheme. It will also prevent the flow of government subsidy on diesel for purely commercial and profitable activities.

However, the industry fears that the move could increase the cost of network expansion significantly. It is overlooking the fact that the operating costs would come down substantially as diesel-based electricity is expensive, costing as much as Rs 15 per unit. But the initial investment and the long pay-back period makes it unattractive for telecom companies. Also, the government is not keen on providing any subsidy for solar power equipment, but says it could offer them soft loans under refinancing schemes of Indian Renewable Energy Development Agency.

THE TIMES OF INDIA

Renewable energy investments surge on China, wind

Global investments in renewable energy surged 31% in the first quarter from the same period last year, driven by wind power and demand in China, says Bloomberg New Energy Finance.

New spending on wind, solar, and geothermal powers through share offerings, venture capital, and asset finance totaled $27.3 billion in the three months through March, compared with $20.8 billion in the first quarter of 2009. 'We stick to our forecast that 2010 will see record overall new investment in clean energy,' says New Energy Finance Chief Executive Michael Liebreich in a company statement. 'We expect the year's total to end up between $175 billion and $200 billion, compared to last year's $162 billion.'

Investments in China were the largest of any country at $6.5 billion, 24% more than the first quarter of 2009. Wind farms accounted for $14.1 billion of the total, 43% higher than in the same period a year earlier. The GWEC (Global Wind Energy Council) said that the wind power capacity is likely grow at an annual average rate of 21% through 2014. 'Even in the face of a global recession and financial crisis, wind energy continues to be the technology of choice in many countries around the world,' says Steve Sawyer, Secretary-General of GWEC.

According to the wind energy council, an industry association, the global installed wind capacity would reach 409 GW (gigawatt) by 2014, compared with 158.5 GW at the end of 2009. China and the United States will lead the expansion, with growth in the Asian nation occurring 'at a breathtaking pace', says GWEC.

The total investment in renewable energy was lower in the first quarter than the $31.6 billion spent in the fourth quarter, says the New Energy Finance. The total was weighed down by Europe, where spending fell to $4 billion from $7.6 billion a year earlier and $6 billion in the fourth quarter. In the United States, asset finance rose to $3.5 billion in the first quarter from $2.4 billion in the last three months of 2009.

BLOOMBERG

Malaysia looking at alternative energy sources

Malaysia will become a net energy importer before the year 2020 and is, therefore, committed to find alternative means, says Deputy Science, Technology, and Innovation Minister Fadillah Yusof. He said that the country's energy requirement was estimated to rise by 6.3% annually and by 2030, the level would reach 28%.

'Towards this end, Malaysia is very much committed to find alternative means of energy that are sustainable,' said the minister in a keynote address at the European Union-Malaysia Biomass Stakeholders Forum, held in Kuala Lumpur, Malaysia.

Fadillah said that the country was in the midst of implementing a number of initiatives with regard to policy review, R&D (research and development), and applications in this area. The ministry had given emphasis to the R&D of renewable energy since the Seventh Malaysia Plan.

In total, 185 projects related to the development of technologies focusing on harnessing energy from resources such as biomass, solar, hydro, wind, and tidal waves, costing RM158 million (more than $49 million) have been carried out. Fadillah said that the ministry had taken the necessary steps to develop a renewable energy technology roadmap in five focus areas comprising of biomass, solar, wind, micro-hydro, and tidal power. 'The use of renewable energy plays an ever increasing role in meeting the requirements of our energy security and the effects of climate change due to the greenhouse gases emission,' he added.

WWW.MYSINCHEW.COM

EDP to buy 1500 MW wind turbines, cut US investment

Power utility EDP (Energias de Portugal SA) has recently announced that it has struck a deal to secure half of its needed wind turbines for the next two years, even as it pulls back on its expansion in the coveted US (United States) market due to regulatory uncertainty. EDP Chief Executive Antonio Mexia has revealed that his company will purchase wind turbines with 1500 MW (megawatt) of capacity from Denmark's Vestas Wind Systems, world's largest maker of wind turbines. Although financial details were not disclosed, the deal is estimated to be worth as much as €2.1 billion!

The turbine supply deal can also be expanded for another 600 MW, based on the global electricity demand trends and the regulatory framework of key markets like the US, which is the world's leading producer of wind energy and one of EDP's fastest-growing markets.

Mexia said EDP had been negotiating the deal for more than a year, but only made the decision now because the technology for wind turbines had improved and the prices had fallen, all thanks to the competition from low-cost Chinese turbine makers.

HTTP://ONLINE.WSJ.COM

Indonesia aims to generate 4000 MW of geothermal energy from volcanoes

The Indonesian government recently announced plans to develop a hot new energy resource. The country's leaders aim to generate 4000 MW (megawatt) of geothermal energy from volcanoes by the year 2014. If the plan proves successful, the renewable energy generated would decrease the country's reliance on coal-fired power plants, reduce its greenhouse gas emissions, and help provide power to the 35% of Indonesia's population who currently live without electricity.

Indonesia is really the perfect place to develop large-scale geothermal projects, as the archipelago's 17 000 islands hold hundreds of volcanoes, and all that heat can be converted to renewable electricity. But while the country holds about 40% of the world's geothermal energy potential, it currently lags behind countries like the US (United States) and the Philippines in developing the technology.

Geothermal's main limiting factor is its high upfront cost. Geothermal plants cost about twice as much as coal-fired power plants, and establishing enough plants to add 4000 MW of energy will cost about $12 billion! But if developers can raise the dough, producing electricity from geothermal energy has lower overhead costs and causes far less pollution than coal plants. The leaders plan to seek the funds to develop more geothermal plants from private investors, the World Bank, the US, and Japan.

HTTP://INHABITAT.COM

Geothermal to supply 10% of energy demands, claims MIT study

MIT (Massachusetts Institute of Technology) has recently released a study claiming that geothermal energy could meet up to 10% of US (Unites States) energy demand by 2050. It took 30 years and an 18-member MIT-led panel to prepare the new study on geothermal energy, since it was last actively researched in the late 1970s and early 1980s.

The US is already ahead of the rest of the world, being the largest producer of geothermal energy. And according to Nafi Toksöz, a geophysicist at MIT, the combined energy of geothermal plants in California, Hawaii, Utah, and Nevada is comparable to all the solar and wind power produced throughout the US.

HTTP://INHABITAT.COM

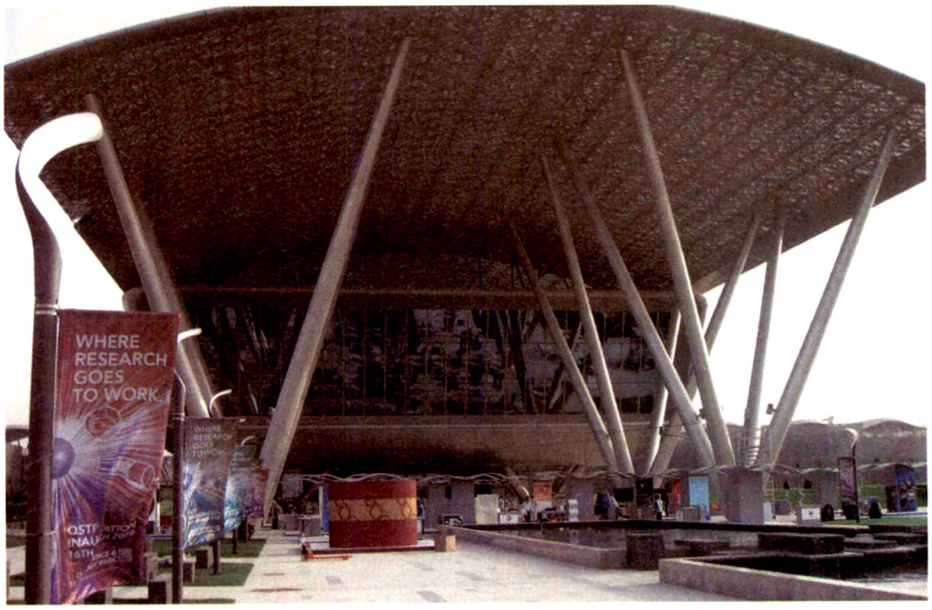
Renewable energy to account for 40% of generation mix by 2030

The use of renewable energy sources is expected to be close to half of developing countries' power generation mix, said Dr Xiaodong Wang, WB (World Bank)'s senior energy specialist for East Asia and Pacific region. She said the World Bank expects renewable energy to account for 40% of the power generation mix by 2030. 'For the Philippines, we also expect it to reach 40% of its generation mix by 2030,' said Wang, adding that clean energy technologies, including renewable energy and nuclear, will account for 50% in a regional basis. She noted that WB's expectations also took into consideration the technical limitations.

'Most of the renewable energy projects we see will be mostly based hydro and geothermal…Solar is the only one that has no technical limits, unlike hydro and geothermal. But since our model is to have the least cost, then solar is beyond our model. So we did not put in much solar in the model as it will shoot up the cost,' said Wang.

HTTP://BUSINESSMIRROR.COM

Chevron and GreenGulf sign agreement to study solar energy in Qatar



Solar Chevron Qatar Energy Technology QSTP-B, an affiliate of Chevron Corporation, and GreenGulf Inc. QSTP-B, a Qatar-based renewable energy and clean technology company, recently announced the signing of a MoU (memorandum of understanding) for a joint study to test solar energy technologies and their application in Qatar.

The research will collect and evaluate the data provided by technologies to be located at a 35 000 sq m solar test site at QSTP (Qatar Science and Technology Park). The project will also study the performance of different photovoltaic and solar thermal technologies. The project supports QSTP's strategy for assisting in the development of a national solar energy industry in Qatar.

Solar technologies vary in their sensitivity to dust and heat and use different amounts of land and water, which can reflect their relative costs. Measurements obtained over a period of years under Qatar climate conditions are expected to help local planners evaluate, select and install technologies best suited to local conditions.

Under the MoU, Chevron and GreenGulf will each invest up to $10 million in the study programme, with Chevron's investment part of an initial $20 million commitment to QSTP. Technology tests are expected to commence in late 2010 and continue for two to four years.

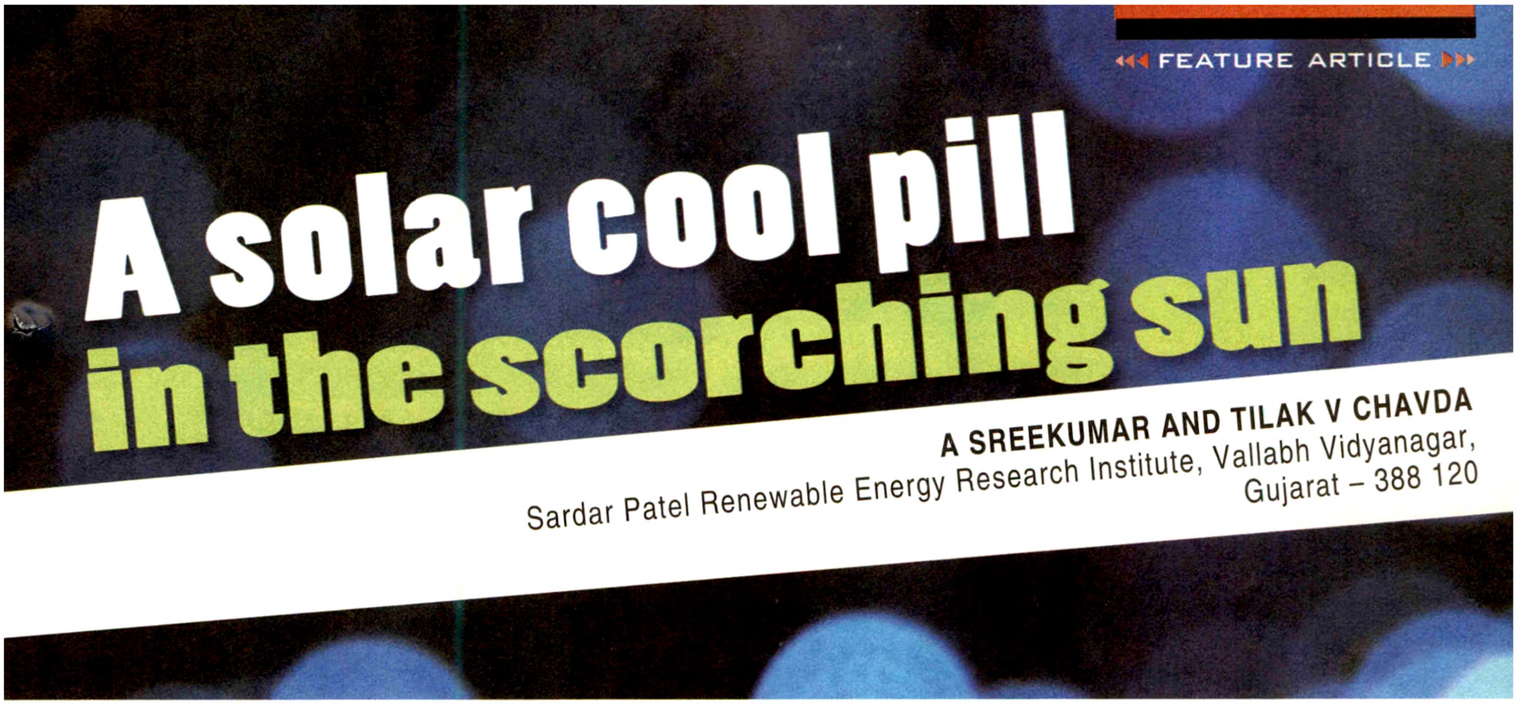
Chevron announced in February 2009 that it will establish its CSEE (Center for Sustainable Energy Efficiency) at QSTP and is now in the process of building the Center. Through the CSEE, Chevron supports Qatar's goal for energy sustainability through research, demonstration, and training of solar power and energy efficiency technologies. The Chevron CSEE will identify solar power, solar air-conditioning, and building-efficiency technologies that work best in Middle Eastern conditions. The Center is scheduled to open in mid 2010.

2010 MENA REPORT

New Jersey cuts red tape to boost solar efforts

New Jersey has scrapped rules that limit the development of solar panels in the state based on their definition as 'impervious surfaces'. The state's Governor Chris Christie recently signed a bill into law that amends restrictions on the amount of land on which impervious surfaces can be built. The new measure amends the definition of 'impervious surface' in land use and coast development laws, so that it applies only to the base of a solar panel system, rather than the entire panel.

The bill, S-921, had bi-partisan backing and sponsorship, and received unanimous support in the New Jersey Legislature. 'There is a balance to be struck between responsible land use law and well-intended but burdensome restrictions that do more harm than good…This legislation removes the regulatory burden, serves our



A solar cool pill in the scorching sun

A SREEKUMAR AND TILAK V CHAVDA
Sardar Patel Renewable Energy Research Institute, Vallabh Vidyanagar,
Gujarat – 388 120

In India, it is estimated that cooling consumes about 35 000 MW of electricity. Part of this comes from conventional plants in areas where electricity is easily available, and the rest is being generated through diesel generator sets, which consume huge amounts of fossil fuels. The total post-harvest loss in rural areas due to improper/inadequate post-harvest technologies is estimated to be 30%–40%, particularly in case of fruits and vegetables. In addition, extensive immunization programmes need to store the vaccines at prescribed temperatures. Solar cooling technology can be effectively brought in to preserve agricultural produce and vaccines.

Use of solar energy for cooling applications is an ideal concept because cooling requirement is maximal during day time, when solar energy is also prevalent. Almost every part of the country is blessed with abundant solar radiation for more than 300 days in a year. Cooling has been the most sought-after application of solar energy. While solar energy can be used to produce cooling in different ways, the vapour compression route, powered by electricity generated from solar energy, is found to be the most suitable one for refrigerators of small capacities that are useful for household purposes, primary health centres, veterinary clinics and small community use, and so on in the countryside.

SPRERI (Sardar Patel Renewable Energy Research Institute) has been at the forefront of developing solar vapour compression technology in the country. Its comprehensive research in vapour compression technology emulates the development of a top-opened SPRERITECH refrigerator. The top-opened model has two compartments to store the material at a preset temperature, specifically meant for vaccine storage. The storage temperature varies from product to product. Thus, the top-opened model allows the storage of products, for which the temperature requirement is more or less same. In order to make the refrigerator store a wide variety of products, a front-opened model has been developed at SPRERI through extensive research and field evaluation. A noteworthy feature of the developed model is that it has three compartments—freezer, middle, and bottom rack and vegetable box. Thermal performance analysis conducted on the system revealed that temperature went down to -14 °C in the freezer compartment, 2 °C in the central part, and 6 °C in the vegetable box. Hence, the developed model could be used to store a wide variety of materials like milk, fruits and vegetables, life-saving drugs, and so on at their appropriate temperature to avoid spoilage. This portable device can play a big role in the remote villages of developing countries where the electricity grid is either not available or erratic.

Basic working principle

In SPV (solar photovoltaic) refrigeration, the cooling effect is produced through the ordinary vapour compression refrigeration cycle as shown in *Figure 1*. The compressed gas leaving the compressor at a high temperature liquefies at the condenser. This liquid gas at a high pressure is then passed through a capillary tube. The resulting low pressure gas evaporates at the evaporator, producing the cooling effect. The DC (direct current) compressor is driven by the DC electricity produced by solar cells.

Major components

The various components of a SPV refrigeration system are PV modules,

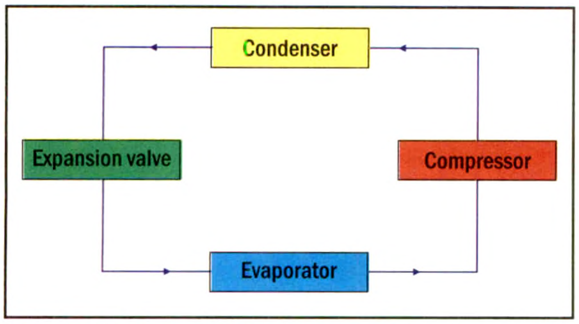


Figure 1 Vapour compression refrigeration cycle

storage battery, solar charge controller, DC compressor-based refrigerator, and connecting cables. Here is a brief description of the various components.

- The PV, direct-drive SPRERITECH solar refrigerator is a chest-type cabinet with an 80-litre internal volume, a front-opening door, a corrosion-resistant coated metal exterior, three thermostat settings, and three compartments. PV refrigerators operate on the same principle as normal compression refrigerators, but incorporate low voltage (12 or 24 Volts) DC compressors and motors, rather than main voltage AC (alternating current) types. The model named FD80 provides front opening, 80 litre storage capacity in three main compartments to store a variety of essential items that require refrigeration. The design features the state-of-the-art skin condenser and is highly energy efficient.
- The SPV array directly converts sunlight into DC electricity. It has no moving parts and is a highly reliable component. The array size is calculated to meet the power requirements of the system, given the solar irradiance data for the proposed site. Depending on the application, solar PV modules of 150 to 200 Watt can provide satisfactory performance.
- Lead acid type, long life, deep cycle batteries are used to store the electricity produced by SPV and power the refrigerator. With a battery of 24 Volt and 130 Ah (ampere-hour), 'no sun autonomy' of up to four days can be obtained, making the refrigerator suitable for most of the critical applications.
- A solar charge regulator is used to protect the batteries against damage due to overcharging or excessive discharge in cloudy weather.
- It has a hermetically sealed compressor, which employs brushless DC motor that operates on 12V or 24V DC power supply. DC compressor that uses environment-friendly refrigerant, R134a (hydrofluorocarbon) and electronic control unit available from Danfoss, Germany, has been used in the solar refrigerator. The unit operates with very low noise level and requires negligible starting current.
- An electronic controller, which converts the DC supply from the batteries into a form appropriate to the compressor, prevents damage to the compressor through over voltage and protects the batteries from deep discharge. It also controls the cooling fan and thermostat.
- The solar array may be either roof type or ground mounting.

Application

Their prime application is in the rural healthcare sector. Refrigerators are a must in health centres for vaccine and blood storage and for making ice for outreach immunization operations. But most centres in developing countries are far from the grid electricity and lack reliable fuel supplies. Under such conditions, use of solar refrigerators has been found an ideal solution to the problem of vaccine refrigeration.

Performance

Thermostat with three settings enables the user to set a wide range of temperature varying between –14 °C and 6 °C. So far, SPRERI has manufactured three FD-80 model front-opened refrigerators, which will be installed at different places in India for demonstration purposes.

Maintenance

Once the system is installed, some regular maintenance is required. SPV

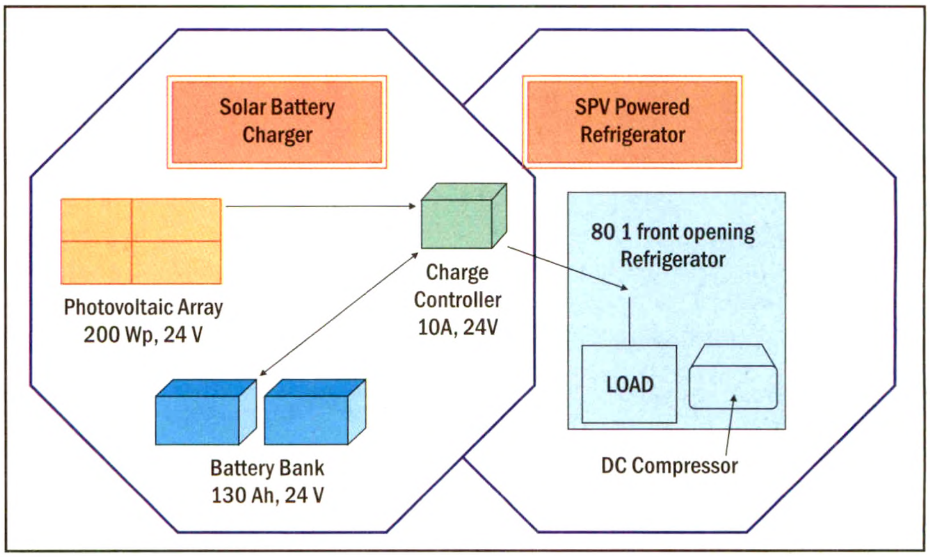


Figure 2 Block diagram of solar refrigerator

Table 1 Technical specifications of the front door 80 litre refrigerator

Parameter	Specifications
Capacity	80 litres
Door	Front opened
Type	Vapour compression refrigerator
Compressor	
Make and model	Danfoss, BD 35 F
Power consumption	60 Watt
Refrigerant	R–134a (HFC)
Operating voltage	12 V/24 V DC
Energy consumption	400 to 600 Wh/day
Min. and Max. internal temperature	(-) 14 to 6 °C at 32°C Ambient
Thermostat	3 settings
Insulation	25 mm thick Polyurethane Foam
Body colour	Silver Hair Line
Weight	18 kg

modules have a life of 15–25 years. For effective use, it should be properly oriented and regularly cleaned. Any obstruction which may throw shadows on the PV modules should be replaced. The refrigerator is expected to work for 10–15 years without any major operational problems and costs. Batteries require regular maintenance to serve their expected life of 5–7 years. The cost of replacing the battery is the only major cost involved in using the refrigerator. The battery should be regularly monitored and cared for.

Cost

The cost of a complete system with 80-litre gross capacity refrigerator is Rs 85 000. The performance of a PV refrigeration system greatly depends on the proper sizing of the system components. The size of the PV array and the battery capacity should be determined according to the availability of solar radiation at the location where it is to be installed. The major hurdle for the large scale deployment is the cost of refrigerator, which is considerably higher than that of AC compressor-based refrigerators.

Model FD80 SPRERITECH Solar Refrigerator

Future models

Work is in progress for the development of a 165 litre capacity, front-opened solar refrigerator, which can store a variety of products. The institute is also developing a solar-powered DC compressor-based refrigerator with ice bank to maintain storage temperature below 8 °C during non-solar hours with autonomy of two days without requiring battery back up. It attempts to eliminate the need for a battery, which amounts to a significant portion of the capital cost and much of the maintenance cost. Prototype unit based on this design have shown positive results.

Conclusion

Solar refrigeration facility, independent of grid supply, for storing the medicines, life-saving drugs, semen, fruits, vegetables, milk, and so on provides an ideal solution to the cooling needs in remote areas where power or fuel supply is either not available or highly erratic. Experience shows that solar refrigerators, if installed and operated as per recommended procedure, give good and reliable performance. SPRERI has already developed and commissioned top-opened and front-opened solar refrigerator of 80 litres capacity for preserving life-saving medicines, drugs, and any perishable products, and the technology has been transferred to the industry. The SPRERITECH refrigerators have been sent to selected centres of All India Coordinated Research Programme on Renewable Energy Sources, Indian Council of Agricultural Research, for multi-location trials at the respective institutions and selected rural locations. All the systems are working well. Dispensaries, hospitals, and *goshalas* in different parts of India are also using the refrigerators with great satisfaction.

Biohydrogen Production Technology

the present scenario

DEBABRATA DAS
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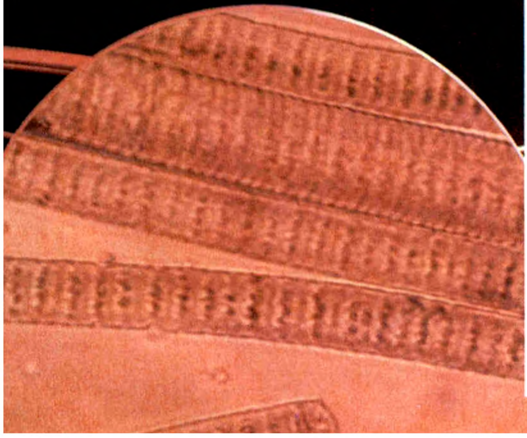
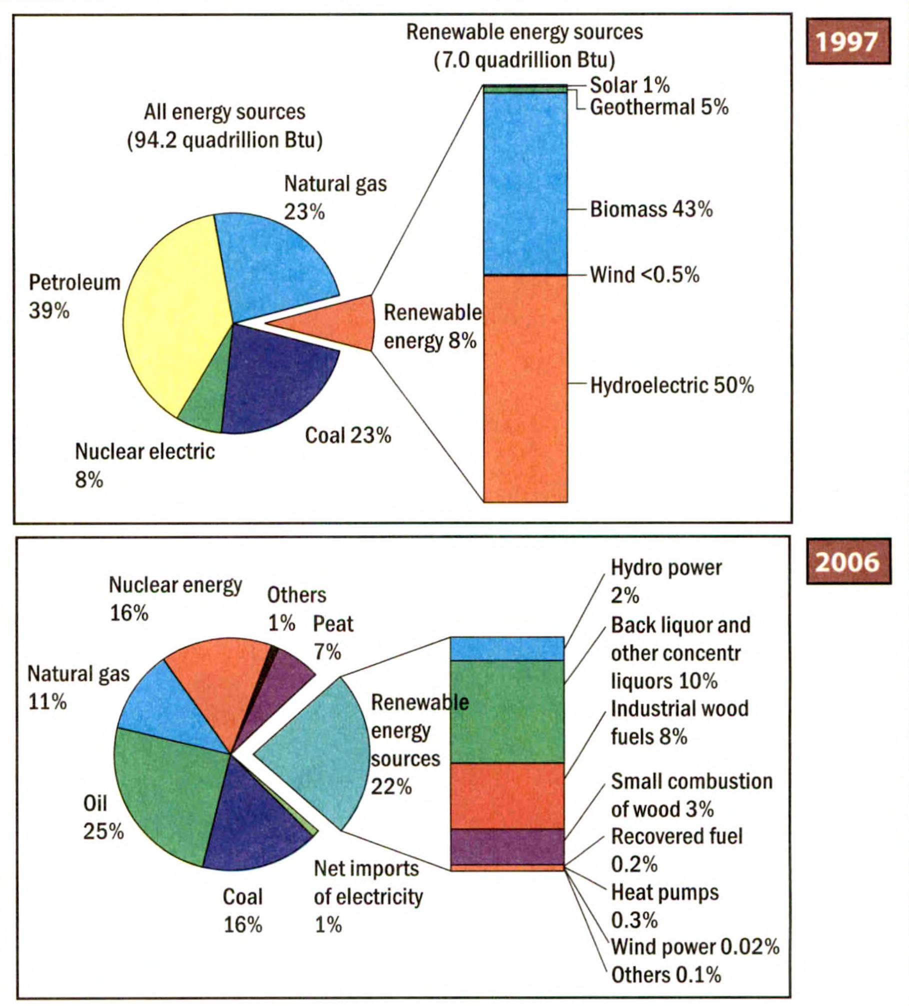
The energy sector holds the key to accelerating the economic growth of our country. It is well known that India will continue to experience an energy supply shortfall in the time to come. The energy scenario has become grimmer since 1985, when the country became a net importer of coal. Rising oil demand of close to 10% per year has led to sizable oil import bills. In addition, the government subsidizes refined oil product prices, thus compounding to the overall monetary loss to the government. This calls for reduction in the oil dependence of the economy, possibly through fiscal measures to reduce demand, and by developing alternatives to oil, such as renewable energy.

In fact, it is this recent breathtaking rise in oil prices that has finally awakened professionals in the energy field to the very real need for alternatives. As a result, we are seeing the rise of non-conventional energy sources like bioethanol, biodiesel, bio-oil, biohydrogen, and the likes. Hydrogen is probably the most competitive of the non-fossil fuel production routes. Hydrogen fuel production technologies can make use of either non-renewable sources or renewable sources such as wind and solar. Hydrogen gas is seen as a future energy carrier by virtue of





World energy scenario: then and now...

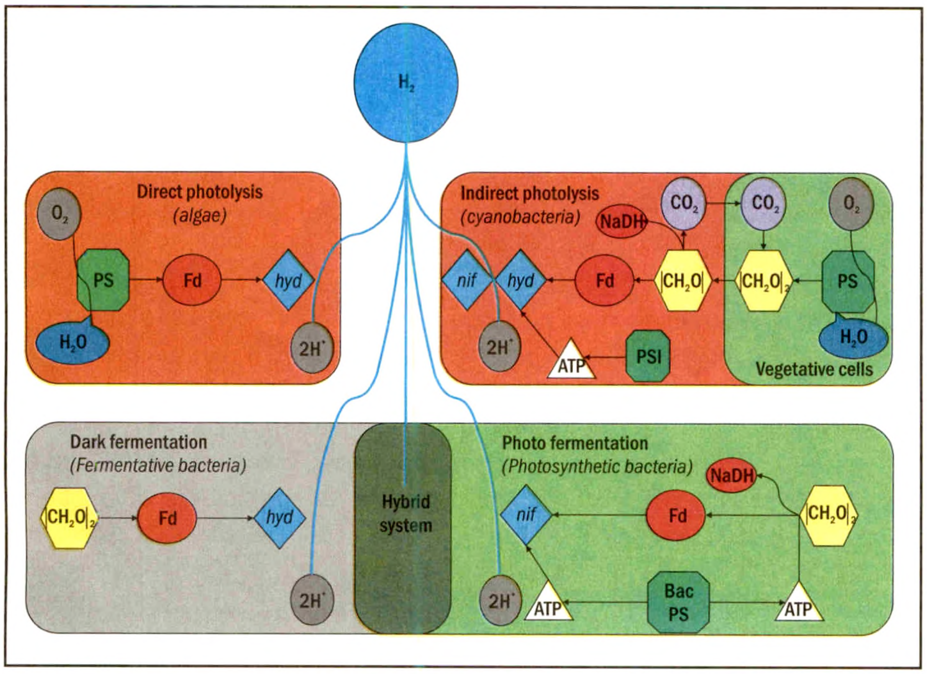
the facts that it is renewable, does not evolve the greenhouse gas CO_2 (carbon dioxide) in combustion, liberates large amounts of energy per unit weight in combustion, and is easily converted to electricity by fuel cells.

Many economists and scientists believe that the economy of the 21st century will be powered by hydrogen, just as petroleum did in the 20th century and coal in the 19th century. Although petroleum had been used since the early 20th century for motor vehicles and airplanes, it took about 50 years for petroleum to overtake coal as the main energy source for the world economy. Though hydrogen research still has a long way to go, it is believed that hydrogen will eventually replace petroleum, driving the world economy from high carbon to no carbon fuel.

However, the problem with hydrogen is that it is merely an energy carrier and needs a primary energy source from which the gas can be obtained. If this first source is a fossil fuel, then hydrogen is not really a clean energy carrier. If the gas is made from the electrolysis of water, which is a rather energy-intensive process, then electricity is needed, and the dilemma remains—where do we get the electricity from? There is, however, a more efficient way to produce the gas in such a way that the stages of the conversion process reinforce each other, instead of working against each other. We are talking about the production of hydrogen from biomass – biohydrogen – in a process that is being designed by several scientific institutions across the world. There are four principal ways by which biohydrogen can be produced—Direct photolysis, Indirect photolysis, dark fermentation, and photofermentation.

BIOHYDROGEN

Some microorganisms produce hydrogen naturally, and biotechnologies based on these microbial systems could lead to the development of clean, renewable sources of hydrogen. Although microorganisms produce hydrogen by different mechanisms, the step can be represented by a simple chemical reaction: $2H^+ + 2e^- \rightarrow H_2$. This reaction is known to be catalysed by either nitrogenase or hydrogenase, the key enzymes involved in biohydrogen production processes.



Various approaches of Biohydrogen Production

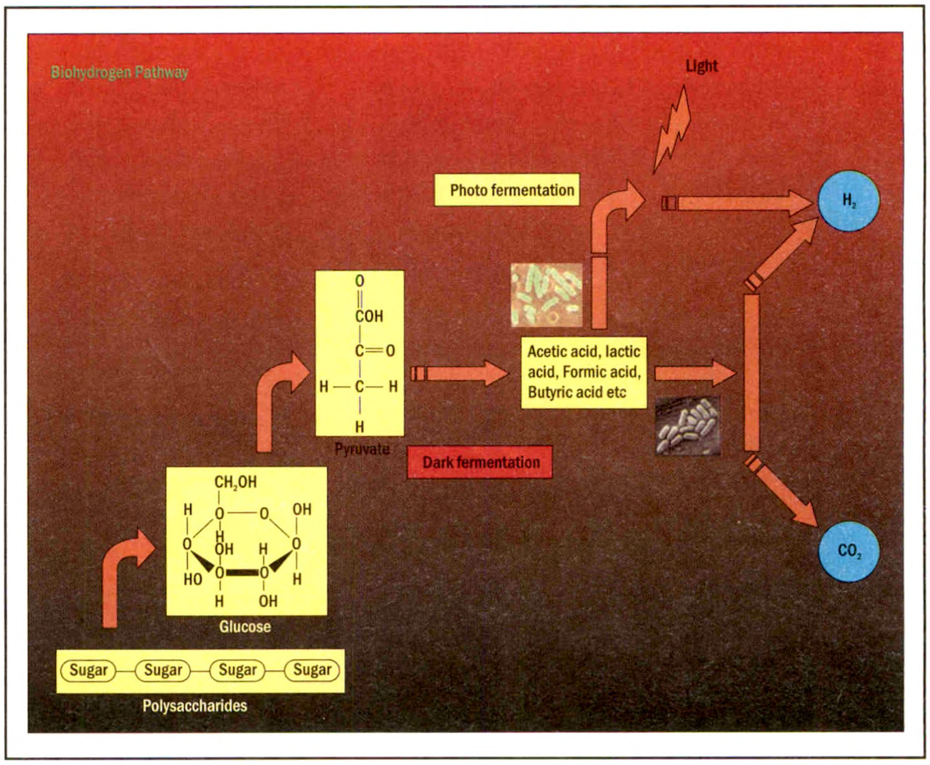
Under certain conditions, green algae and cyanobacteria can use water-splitting photosynthetic processes to generate molecular hydrogen (H_2) rather than fix carbon, the normal function of oxygenic photosynthesis. Bidirectional hydrogenases in these organisms use electrons from the photosynthetic electron-transport chain to reduce protons to yield H_2. Biophotolysis holds the potential for the scale of hydrogen production necessary to meet the future energy demand. This approach to hydrogen production is promising because the source of electrons or reducing power required to generate hydrogen is water—a clean, renewable, carbon-free substrate available in virtually inexhaustible quantities. Another advantage of biophotolysis is the more efficient conversion of solar energy to hydrogen. Reengineering microbial systems for the direct production of hydrogen from water eliminates inefficiencies associated with carbon fixation and biomass formation. Theoretically, the maximal energetic efficiency for direct biophotolysis is about 40%, as compared to a maximum of about 1% for hydrogen production from biomass.

BIOPHOTOYTIC HYDROGEN: AIMS AND IMPACTS

Biological hydrogen production has several advantages over hydrogen production by photoelectrochemical or thermochemical processes. Biological hydrogen production by photosynthetic microorganisms, for example, requires the use of a simple solar reactor such as a transparent closed box, with low energy requirements. Electrochemical hydrogen production via solar battery-based water splitting, on the other hand, requires the use of solar batteries with high energy requirements. Low conversion efficiencies of biological systems can be compensated for by low energy requirements and reduced initial investment costs. Moreover, in laboratory experiments, light energy conversion efficiency as high as 7% has been obtained using a photoheterotrophic process.

Today, energy and environmental protection are two of the most significant issues for sustainable economic development. Environmental microbiologists are looking for new microorganisms with substantially higher energy recovery efficiency. Meanwhile, many research teams are developing various hybrid two-stage processes—generating bio-hydrogen from wastewater at the first stage and using phototrophic bacteria for further hydrogen production process in the second stage.

The Hydrogen thus produced can be used directly as a fuel for internal combustion engines. Hydrogen cars and buses are already in use in Europe and America. The fuel can also be used for airplanes, as demonstrated by the Russians in the 1960s. Furthermore, converting hydrogen into energy is a mature technology in which hydrogen reacts with oxygen producing electricity at an ambient temperature. However, the full scale application of hydrogen as a fuel will be realized with the development of technologies for its safe storage and an infrastructure for its convenient supply to the users.

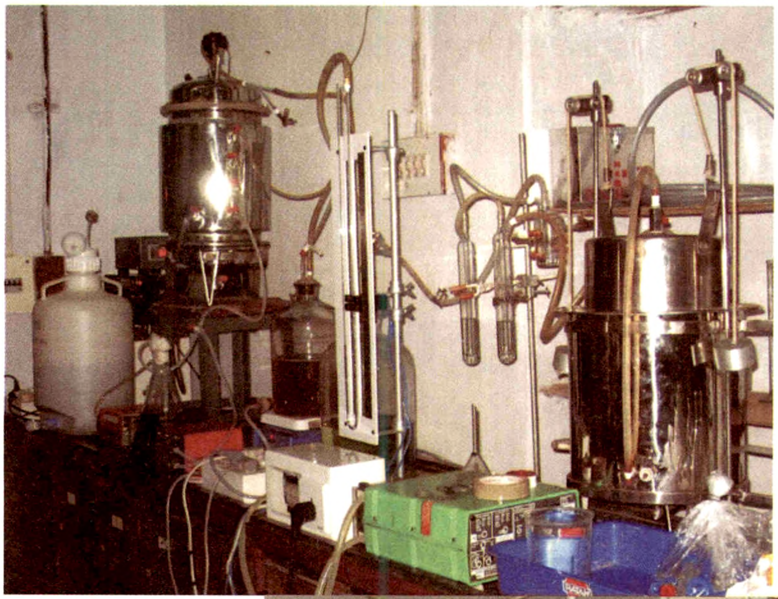


The Biohydrogen Two- Hybrid Pathway

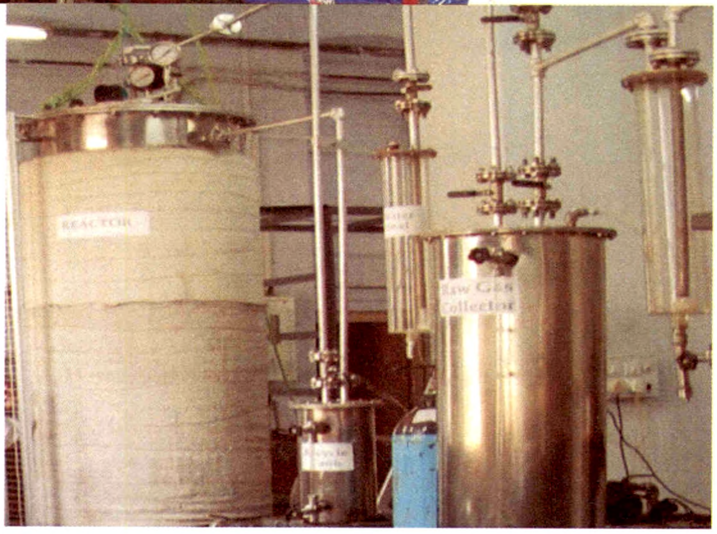
India has taken a leading initiative in Biohydrogen research. The MNRE (Ministry of Renewable Energy), DST (Department of Science and Technology), and DBT (Department of Biotechnology), to mention a few, have contributed greatly to initialize basic research in our country. A number of institutes like IIT (Indian Institute of Technology) Kharagpur; BHU (Banaras Hindu University); MCRC (Shri AMM Murugappa Chettiar Research Centre), Chennai; TERI (The Energy and Resources Institute), New Delhi; IICT (Indian Institute of Chemical Technology), Hyderabad; IIT Delhi; and several other research groups working in national laboratories and academia have taken a lead to develop biohydrogen as a potential alternative energy fuel.

The group at IIT Kharagpur has been involved in the endeavours of biohydrogen production for more than a decade now. Its achievements during this period have been remarkable in terms of strains isolation/manipulation, bioprocess development, reactor design, and bench- and pilot-scale studies on 20L and 800L capacity reactors, respectively, producing around 90L of hydrogen from 180 g of glucose. The laboratory now plans to take biohydrogen research in India to all new heights. With its ambitious project with the MNRE, biohydrogen plants (producing hydrogen from biomass) of 10 000 L capacity may soon be set up under a pilot 'Technology Mission Project' in Kharagpur, Delhi, and Hyderabad.

Whilst IIT Kharagpur has taken a lead role in biohydrogen production from biomass, BHU has taken a lead in fundamental research on hydrogen storage and its application. Under a MNRE project granted to BHU, ICML (International Cars and Motors Limited), Jallandhar (Punjab), is in the process of manufacturing 10 three-wheelers. These will ply between the Central Secretariat and Lodhi Road in



20 L expriment set up



Pilot plant for Biohydrogen production (800 L), IIT Kharagpur

New Delhi. This naturally makes hydrogen-motorized transport obvious to the masses at the heart of the nation's capital. This will be followed by production of 100 hydrogen three-wheelers. Similar efforts are being made for two-wheelers with the help of SIAM (Society for Indian Automobile Manufacturers), which has access to various two-wheeler manufacturers in India. With this, it is clear that Biohydrogen research has taken long strides globally with remarkable contributions to science and technology. This is a landmark achievement, as energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible, and environment-friendly.

The author is thankful to Namita Khanna, Senior Research Scholar, Department of Biotechnology, IIT Kharagpur, for her help in the preparation of this manuscript.

A K DHUSSA, DIRECTOR (WTE) MADE THE CO-CHAIR OF THE AGRICULTURE SUB-COMMITTEE OF THE METHANE TO MARKETS PARTNERSHIP

Methane to Markets is a multilateral partnership, being presently hosted and chaired by the USEPA (United States Environment Protection Agency), which aims to reduce global methane emissions to enhance economic growth, promote energy security, improve the environment, and reduce greenhouse gas emissions. Other benefits include improvement of mine safety, reduction in waste, and improvement of local air quality. It supports various initiatives with a focus on promoting cost-effective, near-term methane recovery and use as a clean energy source. The Methane to Markets Partnership is a collaboration among 33 countries, including developed countries, developing countries, and countries with economies in transition, together with strong participation from the private sector. The Partnership targets four major methane sources and operates though a Steering Committee. There are four Sub-Committees for overseeing the work related with four major methane-emitting areas, namely agriculture (including livestock and agro industries), waste management, coal mines, landfills, and natural gas, and oil systems.

The MNRE (Ministry of New and Renewable Energy) had deputed A K Dhussa, Director (WTE), as a member of the Agriculture Sub-Committee of the Methane to Markets Partnership. At the meeting of the Sub-committee held after the International Expo of the Partnership in New Delhi on 5 March 2010, in view of his expertise in the area of bio-methanation and the large programme on waste-to-energy being implemented by the MNRE, A K Dhussa has been made the Co-Chair of the Agriculture Sub-committee.

Electrification of remote rural area

with hybrid energy system

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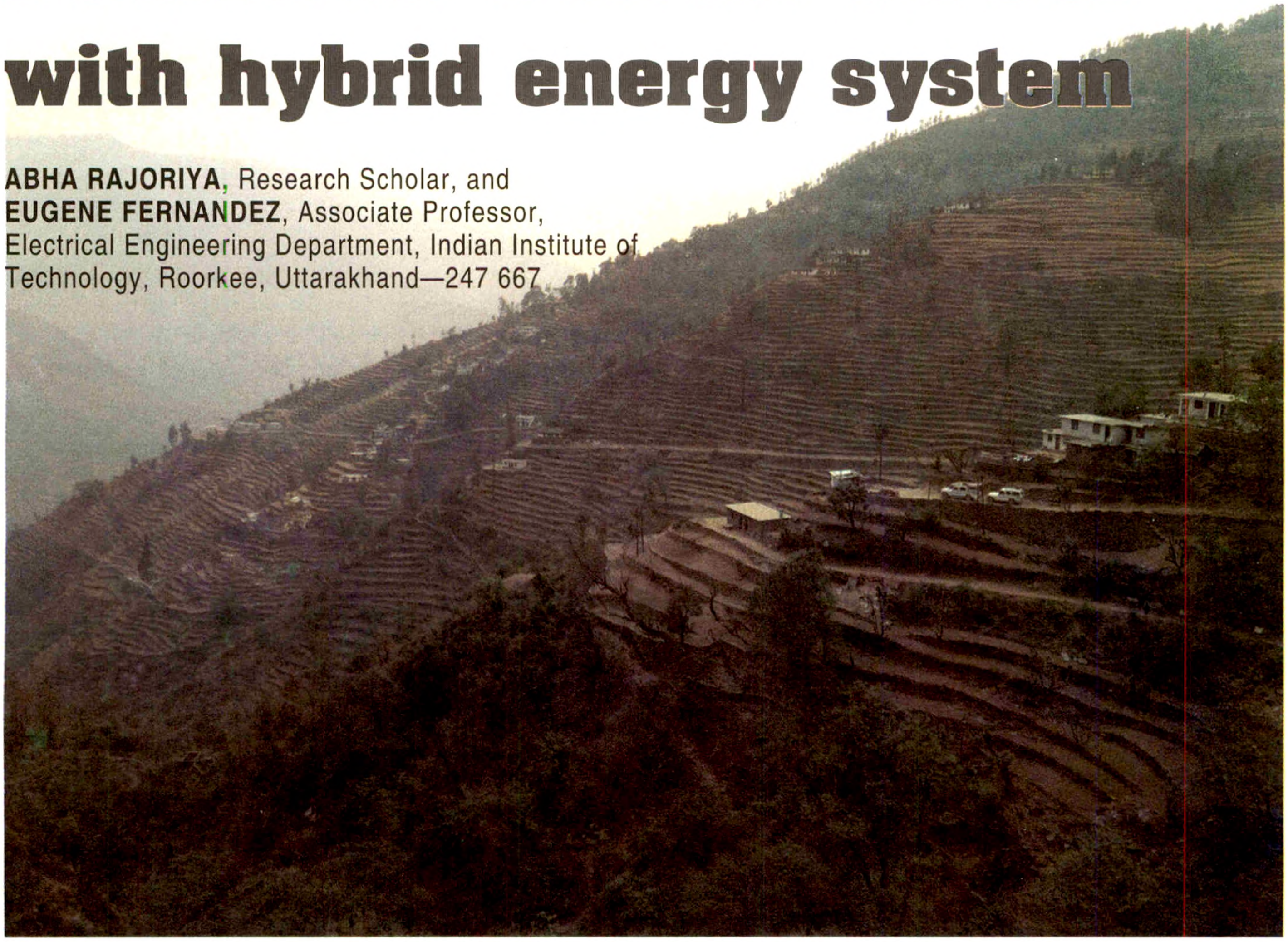

Despite technological advancement in all parts of the world and development in all avenues, there are several areas which are far from supply grid and are not electrified as yet. It is a major challenge for all technical communities to supply electricity to such remote areas. It is often more feasible to get supply from an independent system for such areas, rather than investing in transmission line. An efficient alternative is hybrid energy system, which combines a generation module of renewable sources with backup source. The generation module is often complimentary in nature, appropriately sized to minimize the cost. Backup can be a diesel generator or an energy storage system to achieve a dependable supply. Here is the description on how to design a hybrid energy system for delivering power to a remote village community. The study area for describing the process is a remote village cluster in the state of Uttarakhand.

Introduction

An important form of application of renewable sources of energy is standalone power generation systems for locations where conventional generation is not practicable. These sources are environment-friendly, inexhaustible, and inexpensive in nature, and hence, are attractive energy alternatives for sustainable development. A single renewable energy system, however, would be either too costly or would be an unreliable system due to the intermittent nature of renewable resources. But, supplying electricity from diesel generators alone will increase the pollution level of the area. The solution is the combination of both the sources. Combining diesel generator with renewable energy mix increases the reliability of the supply system, and restricts pollution. Thus, a hybrid energy system could be used to supply power to the remote areas with lesser environmental degradation and reliable power delivery. Any renewable source such as SPV (solar photovoltaic), wind, biomass, small hydro, fuel cell, or a combination thereof added with backup sources such as diesel generator or energy storage devices (battery) is called a hybrid energy system. The schematic of a typical hybrid energy system is shown in Figure 1.

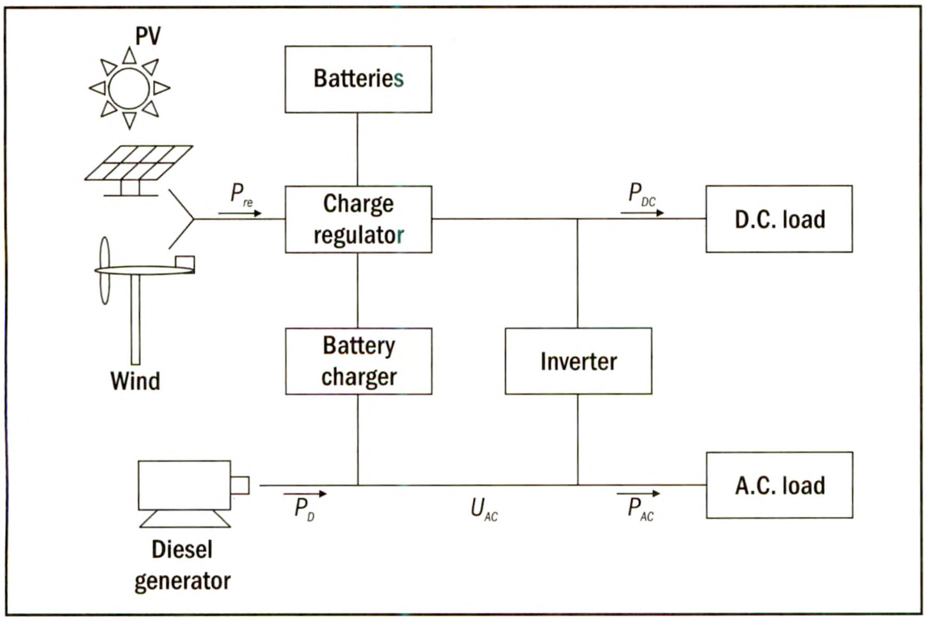

Figure 1 Schematic of a typical hybrid energy system

Study area

To supply power with hybrid energy system, a remote village cluster of the Tehri Garhwal District of Uttarakhand state has been selected as a study area. A map of the study area has been shown in Figure 2. A cluster of 12 unelectrified villages (the area within the circle) has been considered for electrification, employing a hybrid energy system.

The study area has difficult, hilly access and the populace belongs to most poor income group. The area of the district is 4421 sq km^2 and its population is 604 608 as per the 2001 census. It has 1760 villages out of which 1344 villages are electrified and 416 are unelectrified. The study area is in the Tehri tehsil of the Tehri Garhwal district and is an economically weak zone. The inhabitants use kerosene lamps for lighting and employ manual labour for drinking and irrigation water needs. A hybrid energy system for meeting the electricity needs of the region will undoubtedly help in improving the living conditions of the residents of the area.

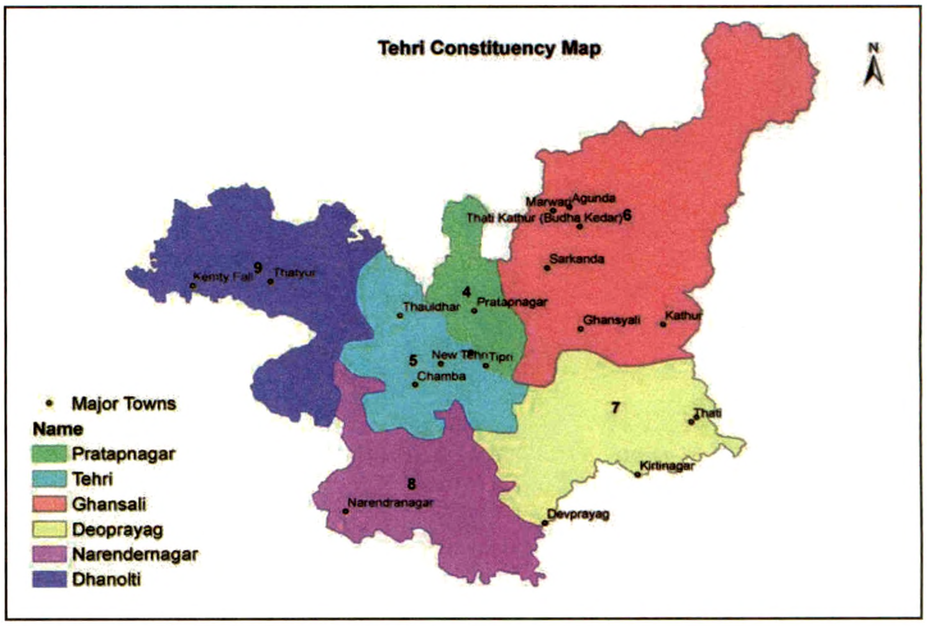

Figure 2 Map of the Tehri Garhwal district showing proposed study area in the circle

Proposed approach

The problem of planning and designing a hybrid energy system is quite complex due to the intermittent nature of the renewable energy sources, load demand uncertainties, nonlinear characteristic of the components involved, and the fact that the sizing and operating strategies of hybrid systems are

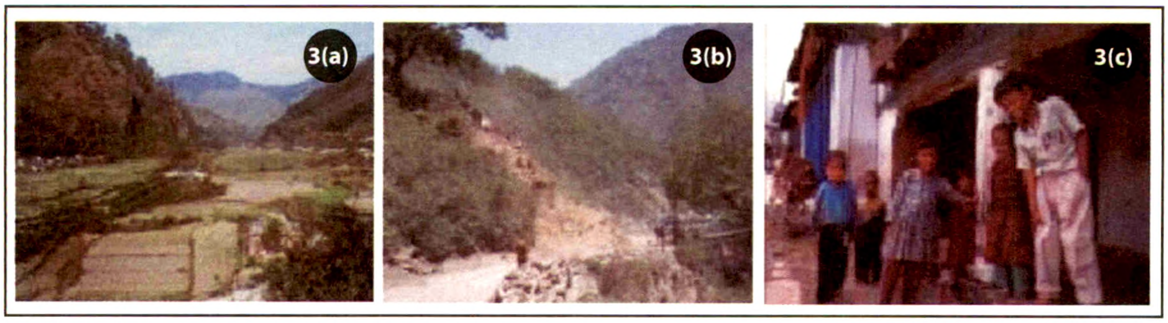

Figure 3 Figure giving an idea of hilly village terrain; its agriculture [Figure 3(a)], difficult access [Figure 3(b)], village living [Figure 3(c)]

interdependent. To transact with such multifaceted problem, NREL's (National Renewable Energy Laboratory) HOMER software has been utilized to realize some significant outputs. Although there are other softwares that also deal with size optimization of renewable energy mix, such as PVSYST, SOMES, RAPSIM, SOLSIM, INSEL, PV-Design Pro, and so on, the advantage of HOMER is that it can simulate all types of renewable sources into a hybrid system and also, carry out optimization of such system. Moreover, it is a free software available on the site of the NREL.

Based on the availability of renewable energies in the remote village cluster, a hybrid system consisting of wind turbine and SPV system, along with a diesel generator backup and battery storage, is proposed for the area (*as shown in the Figure-4*). A converter is additionally required to convert the DC (direct current) output to AC (alternating current) and vice versa. The optimum combination of these resources obviously bears minimum NPC (net present cost), which is the cost of a system spread over its lifetime, and the cost of energy of the system. It must also possess some other features such as dependable supply, lesser reliance on fossil fuel, efficient use of renewable sources, and least environmental degradation.

For the proposed scheme consisting of all the selected resources, the software offers a list of feasible schemes capable of fulfilling the power requirement of the area. The schemes are ranked in the programme output on the basis of NPC (also known as life cycle cost).

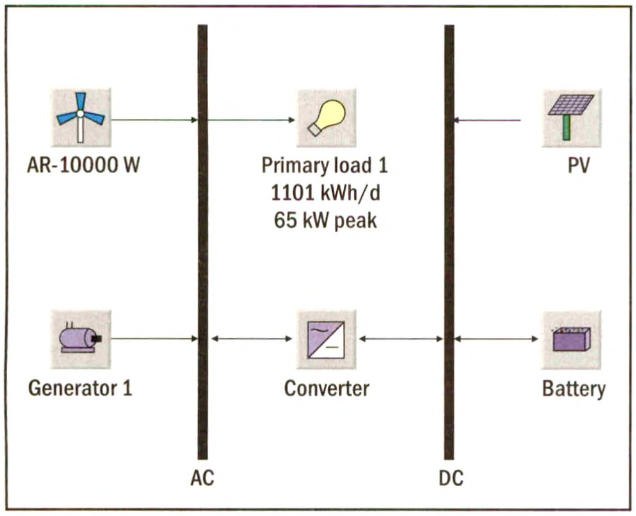

Figure 4 Plan of proposed hybrid energy system

Data inputs for analysis

Depending upon the components involved in the proposed hybrid supply system, the required inputs of various components and study area are to be put in for simulation and optimization. Mainly, three types of data are required—renewable energy potential of the intended area; the capital, replacement, and O&M (operation and maintenance) cost of the components involved; and the load profile or estimated load requirement of the study area. Here is the description of the required data put in for the present work.

Renewable energy resources

Wind resource is the monthly average wind speed in m/s (metre per second) for each month of a year, whereas solar resource is the average monthly radiation in kWh/sq m/day (kilowatt hour per square metre per day) for a year. Details of wind speed available throughout the year in the study area and solar irradiance potential of the study area throughout the year have to be put in for simulation and optimization. Annual average wind speed between 4–5 m/sec would be sufficient to install a wind turbine to achieve efficient wind power output, whereas higher solar irradiance potential will always be helpful for efficient PV system output.

Two renewable resources have been found to be potentially available in the area and suitable for renewable energy mix—wind and solar. Annual average wind speed obtained from nearest metrological station is 5.1 m/s. This wind potential is sufficient for erection of wind energy system. Same wind data has been utilized for analysis of study area. Solar energy potential

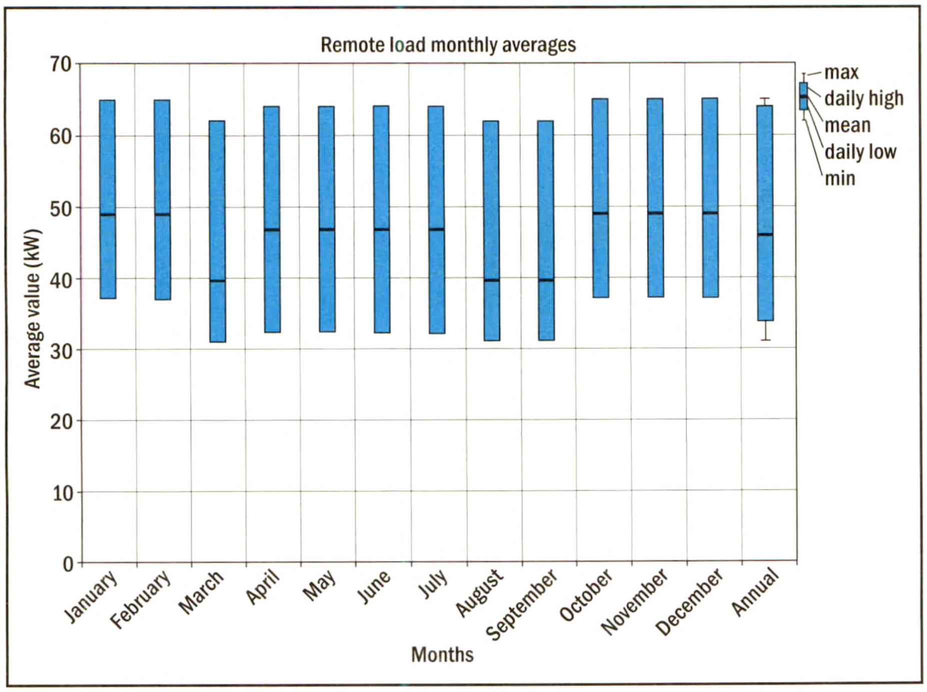

Figure 5 Yearly load profile of the study area

in the area has been found to be ≈5 kWh/sq m/day, which is quite sufficient to install a SPV system.

Load profile of the area

Intended area is not yet electrified. Hence, no present load profile is available for the area. Expected load profile has been obtained by estimating the load requirement of the area, keeping in mind the population and other characteristics such as its geographical location, demographic data, and socioeconomic state of the area. Load profile of other similar villages also helps in the same. Figure 5 gives the yearly load profile of the area.

Size and costs of components in proposed system

A grave market search is required to obtain available sizes as well as capital, replacement, and O&M costs of various components connected in proposed hybrid energy system. While selecting the range of sizes of components, the availability of size, cost of component, maintenance requirement, available land area, and so on have to be kept in mind. Capital, replacement, and O&M costs of these components has been obtained from various manufacturers, considering various factors supplied by the manufacturer such as efficiency, power output, operating hour, nominal voltage, and so on. Sizes of various components in the search space of the software used for simulation are depicted in Table 1.

Results and discussion

Required input of the study area and components involved, enable HOMER to perform hourly time series analysis on hundreds or thousands of combinations of such systems available in the search space. The criterion of optimization is lifecycle cost of the feasible combinations out of several available ones. In other words, the combination that obeys the power balance equation and employs minimum lifecycle cost will be ranked first in the output table of feasible systems. For all the inputs of sizes and cost of components in the present work, the software provides most feasible system on the top of the list of feasible systems. This will be the system with the least of NPC. In the present case, the software performs time series analysis on thousands of combinations of components in order to find out the most feasible system. The system so obtained is shown in Table-2. This would be the system on top of the list with five wind turbines (AR 10), 65 kW DG, 25 batteries (6V.6.94 kWh), and 35 kW converter. The system's initial cost is $94 233 (approx. Rs 4 700 000), whereas its cost of energy is $0.292 (approx. Rs 14.50). Other details of the system, such as renewable fraction, generator hours, and dispatch strategy of generator, would also be seen in the programme output.

Various characteristics related to the feasible systems such as excess energy available, unmet electrical load, and capacity shortage could also be observed with the help of the software. Some other details such as power

Table 1 Size and cost of components connected in the proposed hybrid energy system for simulation and optimization

No.	Component	Unit size	Unit cost($)	Range/No. of component
1.	PV Array	1 kW	5600	0-30 kW
2	Wind Turbine	10 kW	11000	0-5 no.
3	Diesel Generator	70 kW	18000	60-100 kW
4	Battery	6V,6.94 kWh	700	0-50 no.
5	Converter	1 kW	140	20-65 kW

Table 2 List of all feasible hybrid schemes ranked in the order of NPC

					PV (kW)	AR10	Gen 1 (kW)	Batt.	Conv. (kW)	Disp. Strgy	Initial capital	Total NPC	COE ($/kWh)	Ren. Frac.	Capacity Shortage	Diesel (L)	Gen 1 (hrs)
	●	●	●	●		5	65	25	35	CC	$94,233	$1,252,018	0.292	0.16	0.00	126,950	7,897
●	●	●	●	●	1	5	65	25	35	CC	$99,833	$1,253,590	0.292	0.17	0.00	126,412	7,887
	●	●		●		5	65		20	CC	$74,633	$1,268,695	0.296	0.16	0.01	131,452	8,760
●	●	●		●	1	5	65		20	CC	$80,233	$1,272,035	0.297	0.17	0.01	131,112	8,760
		●		●			65		20	CC	$19,633	$1,329,979	0.310	0.00	0.02	146,027	8,760
●		●		●	1		65		20	CC	$25,233	$1,332,678	0.311	0.00	0.02	145,612	8,760
		●	●	●			65	5	20	LF	$23,133	$1,334,711	0.311	0.00	0.02	146,023	8,760
●		●	●	●	1		65	5	20	LF	$28,733	$1,337,411	0.312	0.00	0.02	145,608	8,760

contribution by each component, annualized cost of various components, fuel cost, salvage value of components, and emissions made by each feasible system may also be seen in the various output windows.

However, sometimes, the problem of unavailability of a given selected system necessitates the selection of the next best system. Hence, the list of all feasible hybrid schemes is provided in Table 2. By compromising on NPC, the next best system as per the requirement of the energy planner can be selected. Sometimes, the initial capital in hand or diesel fuel consumption may rank higher while selecting the most suitable system. Thus, the range of feasible systems provides a fairly flexible selection opportunity for the energy planner. Here are some figures demonstrating such hybrid systems. Figure 6 shows a hybrid system installed in Akshi (Maharashtra), Figure 7 shows how erection of wind turbine takes place in such a system, and Figure 8 provides a view of the proposed solar wind hybrid system.

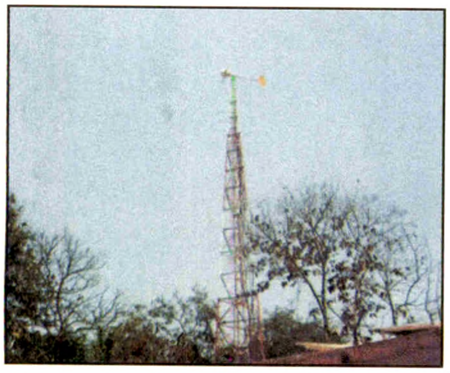

Figure 6 10 KW Wind Solar Hybrid System at grampanchayat, Akshi, Alibaug (Maharashtra)

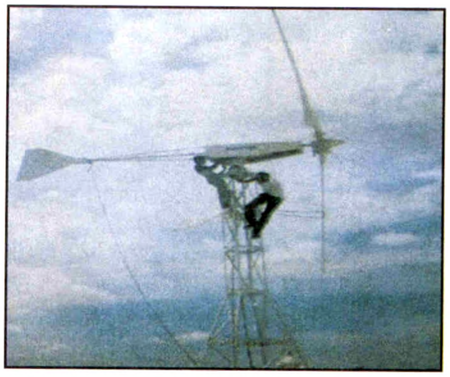

Figure 7 Erection of a small wind turbine

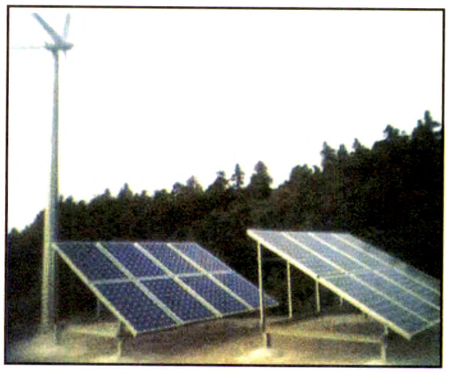

Figure 8 A view of solar wind hybrid system

Conclusion

A description of the process of sizing and optimizing hybrid energy system intended for supplying power to remote rural area is provided here. A typical case study of a village cluster in Tehri tehsil in the Tehri Garhwal District of Uttarakhand shows the process of how to utilize a dedicated software HOMER to achieve the objective. The result so obtained provides optimum hybrid system with the least NPC. The results, however, offer a view of all the feasible systems that are able to provide dependable power supply to the area. This detailed view makes available flexible selection options to the energy planner for supplying power to the area.

The same process, however, can be applied to any remote area to obtain power supply through available renewable resources of the area. The supply can be without grid or can be grid-interactive to supply excess power to the nearby grid and hence, could make revenue out of it.

SOLAR THERMOELECTRIC REFRIGERATION

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Thermoelectric devices gained importance in recent years as viable solutions for applications such as spot cooling of electronic components, remote power generation in space stations and satellites, and so on. These solid state devices are free from moving parts and have good reliability. However, their efficiency depends on the selection of materials. Such devices with higher efficiency can be implemented for refrigeration as well. The combination of Seebeck Effect and Peltier Effect is the absolute advent for such refrigeration. And solar energy is a viable option. The various modes of this technology are discussed in this paper.

The cooling of residential houses and offices with minimum cost and energy consumption is a challenge for these technologies. Nowadays, a lot of techniques focus on the cooling of machines, instruments, computers, laptops, and so on to increase their efficiency and to help them to have a long life by delaying the unexpected heating effects. Computer components have to be kept cool to keep temperatures within design limits (and without the noise of a fan) and to maintain a stable functioning when over clocking. But all this require electric power, which is short of supply and results in energy crisis. This is because electricity is mainly produced by traditional techniques, with high input cost. So, the output generation of electrical power becomes costly.

There is also a method of refrigeration which requires a compressor. Here, cooling is achieved either by vapourizing a refrigerant such as Freon or by absorption, in which the cooling is achieved by vaporizing a refrigerant (ammonia gas). These systems are more expensive and short-aged. Also, compressor systems can leak Freon, which can be extremely dangerous, especially if heated. Absorption systems may use propane, which, too, can be extremely dangerous in the event of a leakage. Hence, to overcome this problem, there should be a technique which is simple, less expensive, easy-to-operate, pollution-free, efficient, and reliable. And all this is possible by the utilization of solar energy. The wonder of converting sun's heat into cooling has been made possible through the advent of thermoelectricity.

Advantages of thermoelectric conversion

The major advantage of this technique is that it is pollution free. The entire device arrangement does not have moving parts. It does not contain any gas, compressor, or refrigerator like the other refrigeration systems. Due to these reasons, its operation is very easy. Also, it is a technique which converts the low-grade waste heat into electricity. Although it demands more efficient materials, which may be expensive, but it influences the reliability and leads to better results. The thermo emf (electromotive force) can also be stored, and sometimes recycled, to improve the output of the system.

Availability and utilization of solar energy

The input or raw material for solar refrigeration is the sun's heat. As the sun's energy can be utilized by solar cells, solar cell panels can be integrated with this technique. Wind energy can also be utilized to get maximum output, especially in regions where wind energy farms are available. However, solar energy is available in adequate amounts everywhere (though it can vary), and is free of cost and can be utilized without pollution, without any special agent, or other requirements. In the hot regions, the results better as compared to cold regions.

Principle

The well-known phenomenon, Seebeck effect, is implemented in the form of thermocouples, which are assemblies of two different metals joined at the two ends called junctions. When temperature gradient is established at the two junctions, thermo emf arises (see figure1). This is due to the arising of contact potential at the junctions when the electrons tend to drift from the high density (charge carrier) region to lower density regions. Common metals which are inexpensive and easily available can be used for thermocouples. If a series of thermocouples is piled in a suitable cover and one of their ends is heated by solar energy (without any combustion), and the other end is kept cold (at low temperature) by alternate means, then it will generate thermo emf. In other words, it is a technique to convert the sun's heat into electricity. However, if the electric and magnetic fields are available along with the waste heat, then the thermo emf will be enhanced. When this emf is applied to any one junction of a thermocouple, at the same temperature, then one of its end becomes hot and the other one will remain cold (see Figure 2).

This principle is known as the Peltier effect. This can be explained by imagining the electron clouds within the two metals. One electron cloud will be denser than the other, and consequently, electrons will want to jump to the lower electron density, producing a potential difference. When the moving electrons collide in high electron density, it causes resistance and hence, produces heat in the junction. But the other junction will have negative resistance, leading to cooling. This means the Peltier effect cools one end and heats the other, which can again be recycled to the Seebeck. Hence, the sun's heat can be converted into cooling by the combination of Seebeck and Peltier principles as shown in Figure 3.

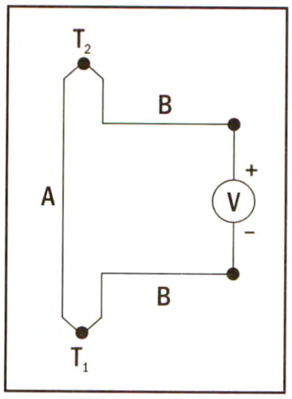


Figure 1 Thermo emf from seeback effect

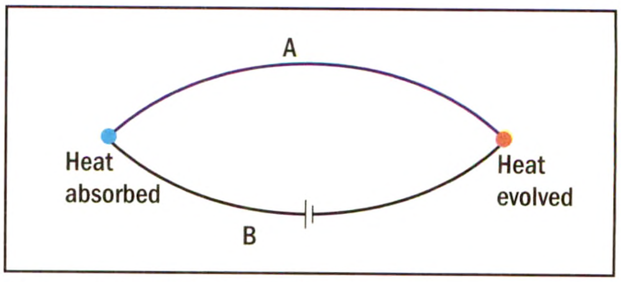


Figure 2 Cooling from peltier effect

Coefficient of performance

In 1912, Altenkirch introduced the concept of figure of merit when he showed that good thermoelectric materials should posses high Seebeck coefficients, high electrical conductivity to minimize Joule heating, and low thermal conductivity to retain heat at the junctions that will help to maintain a large temperature gradient. Ioffe in 1957 presented the figure of merit as $Z = \alpha 2\sigma/\lambda$. The performance of a thermocouple for the emf generation is given by the dimensionless quantity, $ZT = \alpha 2\sigma/\lambda$; where α is the Seebeck constant, ZT is coefficient of performance, σ is the electrical conductivity of the thermoelectric material and λ is the thermal conductivity of the thermoelectric material. This is crucial as there are two aspects of cooling—of electronic devices and of buildings. The Seebeck–Peltier combination can be applied on both only by some variations in designing, introduction of solar panels, voltage storing systems, and thermocouple chip devices. The output will also vary in these proportions.

History of developments

Initial thermoelectric materials that were studied were metals, which display Seebeck coefficients of a few tens of μV/K. But other materials, including semiconductors, are studied from the point of view of Phonon Drag theory, according to which the thermal conductivity can be reduced by providing the interactions to phonons; which are the heat carrying particles. Such results are possible by alloying the semiconductors, by changing their structures, their compositions, and from the use of nanotechnology. In 1956, Ioffe et al. suggested that alloying a semiconducting thermoelectric material

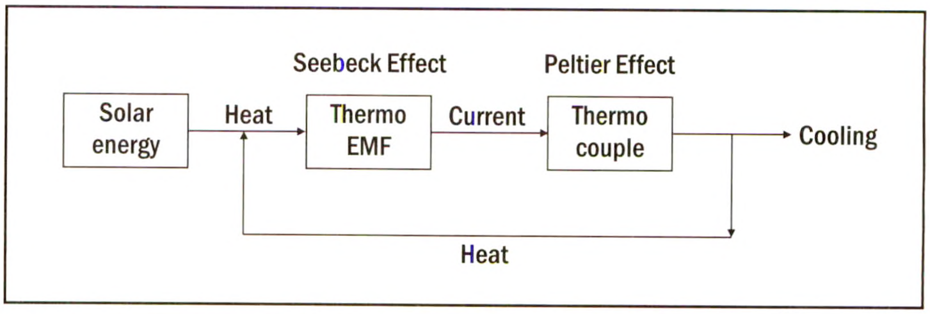


Figure 3 Energy circle representing cooling from solar energy

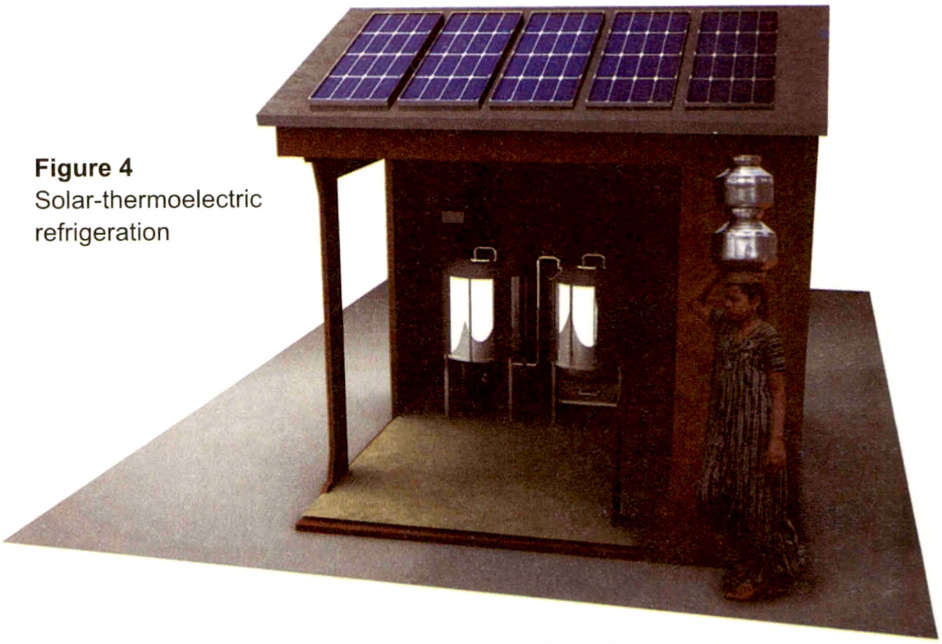


Figure 4
Solar-thermoelectric refrigeration

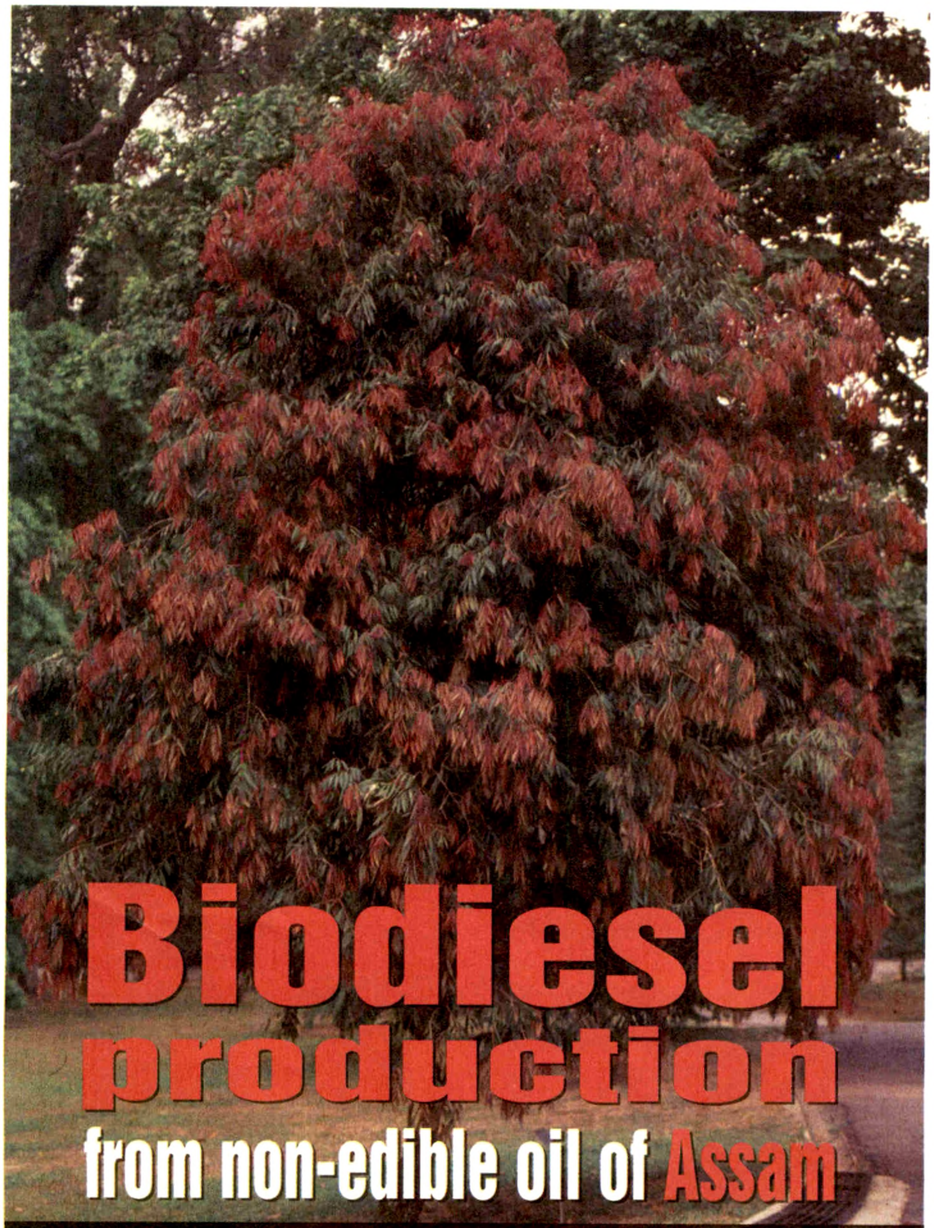
with an isomorphous substance – materials with the same crystalline structure – would enhance the coefficient of performance by reducing lattice thermal conductivity without affecting the carrier mobility. Birkholz in 1958 and Rosi in 1959 showed that alloying Bi2 Te3 with Sb2Te3 greatly reduced the thermal conductivity. Similarly, in nanowires/nanomaterials, in which the particle size is very small and high volume to surface ratio, the phonons face some interactions but at the same time the electrons drift without any obstacles. This reduces the thermal conductivity and increases or maintains the electrical conductivity. The biggest advent was silicon nano wires. The advent of quantum well nanofilm and nanowire superlattice structures that improve the value of ZT due to a number of advantages has shifted to understand the carrier transport behavior in nanostructures. Quantum confinement in nanostructures increases the local carrier density of states per unit volume near the Fermi energy, increasing the Seebeck coefficient, while the thermal conductivity decreases due to phonon confinement. One of the advanced developments is the study of thermo emf in the regions where the low-grade waste heat is available along with the electric and magnetic fields, which can improve the conversion efficiency.

So, for better performance of such devices, materials with high electrical conductivity and low thermal conductivity are being selected. Thermocouples in the form of wires can be used. They are also available in powder form, thin films, gel, alloys, and nanotubes for better achievements. The nanowires, which have large volume to surface ratio, cause some interactions with phonons. This helps to reduce the thermal conductivity and increase the performance of the instruments. Hundreds of thermocouples on a single chip, making use of solar-assisted thermoelectric modules, are also in practical use as shown in Figure 4.

This makes the devices compact and handy. Such devices can be applied to industries, buildings located in hot regions, and to the houses in summer. However, they require some modifications related to their size and the selection of materials. But their advantages, like cost effectiveness and low level of pollution, are enough to motivate the engineers for implementations. In instruments like computers, laptops, dynamos, and vehicles, the low-grade waste heat can be utilized for cooling and can also be recycled to improve their performance. To reduce the thermal conductivity, the heat-resistant membranes can also be used. In large number of devices, metallic blocks are used, which causes eddy currents due to non uniform magnetic fields. If these magnetic fields are synchronized to the thermo coupled devices, it is observed that the thermo emf is enhanced, which results in more cooling.

At present, the noble thermoelectric materials with high COP (coefficient of performance) like Bismuth Telluride, Lead telluride, and Silicon Germanide are more expensive. But the researches are oriented to develop cheap, easily available, and efficient metals and semimetals, as this technology is of great interest because it does not require a compressor or refrigerant, is low noise, and has no moving parts. For this reason, they are very suitable for the cooling of lasers or microprocessors. It involves the utilization of solar energy. In most thermo-coupled devices, there are not many precautions, risks, or extra requirements for designing and fabrication.

The advent of thermocouples by Seebeck and Peltier principles to get cooling may face some problems in the beginning, but its reliability, cost-effectiveness, and environment-friendly characteristics will attract the engineers and scientists to overcome energy crisis. The nanomaterials have the capacity to improve the performance of such devices, but need further research. The advanced mathematical models, quantum well models, and alloying techniques of both metals and semiconductors can enrich this technique.



Biodiesel production from non-edible oil of Assam

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The results of the study show that the seed oil of Mesua ferrea L. tree can be used as the source of feedstock for biodiesel production. Density, flash point, water content, ash content, and sulphur content of neat biodiesel were found to be within the acceptable limits as per the ASTM (American Society for Testing and Materials) standards for biodiesel.

Introduction

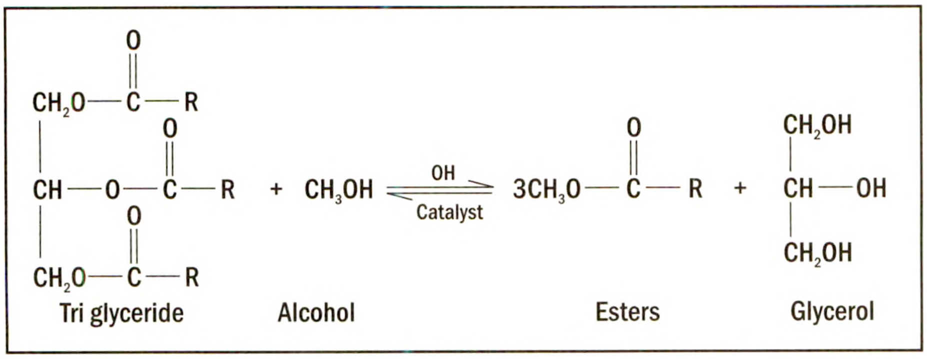
In recent years, the interest in biodiesel has been increasing, motivated on the one hand by the need for reducing greenhouse gas emissions and on the other hand, by the desire to improve energy security by reducing our dependence on imported oil.

Biodiesel is a generic name for fuels obtained by transesterification of vegetable oils and animal fats. The term 'biodiesel' was first introduced in the US (United States) in 1992 by the National Soy Development Board (now called the National Biodiesel Board). Non-edible plant oils are in focus for the production of biodiesel in recent times due to the limited availability and high demand for edible oil. Biodiesel can be produced from a variety of feedstocks, including Karanja, Polanga, Mesua ferrea L., Semaruba, Rubber seed, Cotton seed, Neem, and Sal.

The use of vegetable oils as an alternative renewable fuel to compete with petroleum was proposed in the beginning of the 1980s. However, this oil could not be used directly in the diesel engines because of its high kinematic viscosity. High viscosity of oils would reduce the fuel atomization and increase fuel spray penetration, which would be responsible for high engine deposits. One of the technologies to reduce the viscosity is by transesterification of plant oil. Transesterification reaction can be achieved either by a base or an acid catalyst, based on the acid value of plant oils.

Transesterification or alcoholysis is the chemical reaction between triglycerides and alcohol in the presence of catalyst to produce monoesters and glycerol. That is why transesterification of vegetable oils appears to be more suitable because the byproduct, glycerol, has commercial value. The transesterification reaction can be represented by the following equation.

Stoichiometrically, three moles of alcohol are required for each mole of triglyceride. But in practice, a higher molar ratio is employed in order to displace the equilibrium for getting greater ester production. The important factors that affect the transesterification reaction are the amounts of methanol and catalyst, reaction temperature, and reaction time. Some of the commonly



used short-chain alcohols are methanol, ethanol, propanol, and butanol.

Methanol is used commercially because of its low price. Alkaline hydroxides are the most effective transesterification catalysts, as compared to acid catalysts. Potassium hydroxides and sodium hydroxides are the commonly used alkaline catalysts.

Transesterification process may be accomplished with the help of base, acid, or lipase as catalyst. However, base catalysed transesterification of oils is the widely accepted method for preparing biodiesel, particularly for low acid number oils.

The chemical composition of fat and oil esters depends upon the length and the degree of unsaturation of the fatty acid alkyl chains. The most important compositional differences between petroleum diesel and biodiesel are oxygen content. Biodiesels contain 10%–12% wt oxygen, which lowers energy density. Acids may be saturated or unsaturated (contain one or more double bonds). Depending on the nature of the fatty acids present in the source, the fuel properties of the biodiesels may differ to varied extents. Table1 shows the chemical structure of the fatty acid chains found in the most common biodiesel source materials.

Biodiesel generally provides significant emission benefits with respect to CO (carbon monoxide), UBHC (unburned hydrocarbon), and PM (particulate matter), but slightly higher NOx (oxides of nitrogen).

Mesua ferrea L. tree is a mid-sized tree that grows mostly in the mountains of the eastern Himalayas, eastern Bengal, eastern and western Peninsulas, and Andaman Islands. In Assam, it is generally found in Upper Assam, the Darrang district, and North Cashar Hills. Its seeds contain 75% of oil on the basis of shelled kernel weight. Flowering starts in April–May, and seeds become mature in August–October. A fully mature tree yields about 30–60 kg of seeds annually. Mesua ferrea L. is one of the hardest trees of North East India. Its timbers are used in construction of houses, furniture, cart wheels, and so on. In early days, when kerosene and electricity were not available, the rural people of this region used the seeds of Mesua ferrea L. for illumination at night. Mesua ferrea L. oil and seeds are shown in Figures 1 and 2. In the present investigation, non-edible plant oil of Mesua ferrea L. was taken for transesterification. Biodiesel samples obtained from the experiments were tested for density, ash content, carbon residue, pour point, flash point, water content, kinematic viscosity at 40 °C, oxidation stability, and calorific value as per the ASTM D287, D874, D4530, D97, D93, D2709, D445, D2274, and D240. It was found that the biodiesel obtained from Mesua ferrea L. oil conformed to

Table 1 Chemical structure of the fatty acid chains found in the most common biodiesel source materials.

Acid chain	No. of carbon atoms	Structure
Caprylic	8	$CH_3(CH_2)_6COOH$
Capric	10	$CH_3(CH_2)_8COOH$
Lauric	12	$CH_3(CH_2)_{10}COOH$
Myristic	14	$CH_3(CH_2)_{12}COOH$
Palmitic	16	$CH_3(CH_2)_{14}COOH$
Palmitoleic	16	$CH_3(CH_2)_5CH=CH(CH_2)_7COOH$
Stearic	18	$CH_3(CH_2)_{16}COOH$
Linoleic	18	$CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COOH$
Linolenic	18	$CH_3CH_2CH=CHCH_2CH=CHCH_2CH=CH(CH_2)_7COOH$
Arachidic	20	$CH_3(CH_2)_{18}COOH$
Eicosenoic	20	$CH_3(CH_2)_7CH=CH(CH_2)_9COOH$
Behenic	22	$CH_3(CH_2)_{20}COOH$
Erucic	22	$CH_3(CH_2)_7CH=CH(CH_2)_{11}COOH$

Figure 1 Mesua ferrea L. oil

Figure 2 Mesua ferrea L. seeds

the standard specified by the ASTM and was comparable to diesel fuel.

Materials and methods

About 100 kg of Mesua ferrea L. seeds were collected from mature trees grown in the forests of Assam and dried in a hot air oven. The dried seeds were shelled and milled. The oil was extracted from the milled kernels, with petroleum ether using the Soxhlet extraction method. The solvent was removed from the extract and the oil content was found to be 75% by weight of the milled kernel. About 10 litres of the oil were extracted and kept over anhydrous sodium sulphate for three days and filtered through glass wool to remove the PM present in it. The filtered oil was then stored in glass bottles. The Mesua ferrea L. oil (3 litres) was heated up to 65 °C in a round bottom flask. A solution containing about 30 grams of KOH (Potassium hydroxide) dissolved in methanol (1.5 litres) was poured into the round bottom flask, while stirring the mixture continuously. The mixture was kept at 65 °C for three hours and then allowed to settle under gravity in a separating funnel. Out of the two layers formed, the upper layer was of MOME (Mesua ferrea L. oil methyl ester) and the lower layer was of glycerol. The lower layer was separated and the ester was mixed with 10% (by volume) hot water, shaken properly, and allowed to settle down for 24 hours. The water containing KOH in the lower layer of the separating funnel was removed. The remaining moisture from the purified ester was removed using crystals of silica gel. The yield of esters thus produced was 95%. Various properties of the biodiesel thus obtained from Mesua ferrea L. seed oil was determined by the ASTM methods. Methyl ester quality was checked by NMR (nuclear magnetic resonance) spectroscopy (Bruker ARX-400 spectrometer; Bruker, Rheinstetten, Germany; 400 MHz for 1H NMR; solvent CDCl3).

Results

The maximum yield of biodiesel obtained from Mesua ferrea L. SVO (straight vegetable oil) is 95%. The uncertainty was calculated and found to be ± 0.0254. Proton NMR [1H (hydrogen) NMR] is a reliable technique for the estimation of biodiesel formed in the transesterification process. 1H NMR spectrum of Mesua ferrea L. methyl ester was taken. The result reveals a more accurate quantification of biodiesel content in the reaction mixture. Figure 3 presents a typical NMR spectrum of Mesua ferrea L. methyl ester. A triplet at 2.3 ppm (parts per million) and a singlet at 3.7 ppm correspond to signals due to methylene protons adjacent to the ester group in triglycerides and the methoxy protons of the methyl esters. All tests were carried out in triplicate and the average values are shown in Table 2.

Table 2 Fuel characteristics of biodiesel obtained from Mesua ferrea L. seed oil

Property	MOME
Density at 15 °C g/cm³	0.897
Kinematic viscosity at 40 °C cSt	4.2
Water content % vol	0.035
Ramsbottom carbon residue %wt.	0.250
Pour Point °C	-1
Flash point °C	150
Sulphur content %wt.	0.007
Ash content %wt.	0.01
Oxidation stability g/100ml	0.120
Copper strip corrosion	1a
Calorific value MJ/kg	42.23

Conclusion

Transesterification is a process which brings about a change in the molecular structure of the vegetable oil molecules, thus bringing down the kinemaic viscosity of vegetable oils. The density and kinemaic viscosity of MOME formed after transesterification were found to be very close to diesel fuel. The flash point of methyl ester of the plant oils was higher than the diesel fuel. The present analysis reveals that biodiesel from Mesua ferrea L. oil is quite suitable as an alternative to diesel fuel.

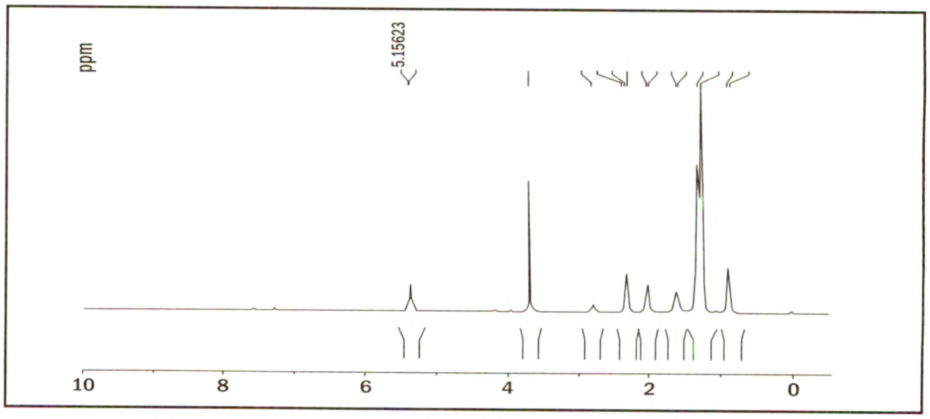


Figure 3 NMR spectrum of Mesua ferrea L. methyl ester.

BIOMASS, BIOFUEL, AND FOOD SECURITY

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Food and energy security are at the forefront of environmental issues, engaging the attention of all countries. And climate change poses fundamental threats to Asia's food and energy security, which if left unchecked, will result in an upsurge of migration into the already overburdened mega cities. Biofuels have come into prominence as they are considered to be an environment-friendly energy source with the potential for reduced gas emissions. Energy inputs into biomass production, transportation, and conversion are assumed to be biomass based, resulting in a CO_2-neutral (carbon dioxide-neutral) fuel cycle. The CO_2 released in biomass combustion is assumed to be balanced by the CO_2 removed from the atmosphere when the biomass was grown. Biofuels are a viable option for achieving the targeted gas emission reduction by many countries. But, any attempt to divert land for biofuel is not a viable option, as the demand for food is rising rapidly. More alarming is the forecast that food prices will increase by 20%–40% in the next decade. Problem is not about choosing food versus fuel production, but it really centres on poor (inequitable) distribution of food between those who produce food surpluses and those who need food but are at some distance from where it is produced or to purchase it in the marketplace. If it is not a food shortage problem but one of distribution of existing food supplies, it is not necessary to be concerned about a 'fabricated' conflict between food vs fuel needs.

Cellulosic biomass resources are abundant and have multiple application potential and can be converted to ethanol by hydrolysis and subsequent fermentation. In India, the total crop residue including fodder and non-fodder production during 1996/97 was estimated to be 626 Mt (million tones) of air-dry weight. The dominant residues are those of rice, wheat, sugarcane, and cotton, accounting for 66% of the total residue production. Crop residues, which are used as fodder, will not be available as feedstock for energy. The total potential of non-fodder crop residues available for energy is estimated to be 325 Mt and 450 Mt for 1996/97 and 2010, respectively. Besides this, a portion of the agri-residues (rice, wheat straw, corn stover, stalks, leaves, and branches), which are presently burnt or left in the field due to mechanized farming (especially in Punjab, Haryana, and other parts of the country) may, therefore, be utilized for biofuel production. Ethanol production technologies for sugar (cane, beet molasses, and in small quantity sweet sorghum) and starch crops (grains) are well-developed, but have certain limitations. Oil from Jatropha curcas seeds is used for making biodiesel fuel in Philippines and Brazil, where it grows naturally. Likewise, Jatropha oil is being promoted as an easily grown biofuel crop in hundreds of projects throughout India and other developing countries. However, Jatropha suffers from certain limiting factors such as the availability of high yielding Jatropha saplings to the grower, low yield on marginal land, and land availability. But the real challenge lies in the efficiency and cost effectiveness of the technology that requires focused R&D (research and development) and governmental policies.

Introduction

The total world consumption of energy equivalent is about 10 billion tonnes of crude oil, of which 80% comes from fossil fuels. The commercial energy consumption in the developed world has increased during the last three to four decades and is more than 80% of the total world consumption. And 20% of the energy is consumed by 70% of the world population in developing and social countries. India ranks sixth in the world in terms of energy demand with total energy consumption of around 480.4 Mt, of which 53% is from fossil fuels. But India produces only about 25% of the total energy requirement. The country has imported about 99Mt of crude oil during 2005/06, as reported by the Ministry of Petroleum and Natural Gas, causing a burden of Rs 171 702 crores on foreign exchange.

The global energy security concern, along with the growing interest in the environmental benefits associated with the use of renewable energy, has resulted in wide-ranging government policies that promote biofuel production. It is also driven by the Kyoto Protocol, which mandates greenhouse gas reduction to the member countries. Biofuels are, thus, considered to be a viable option for achieving the targeted reduction by many countries. India has experienced a dramatic growth in fossil fuel CO_2 emissions at the rate of 5.9% since 1950. Biofuel is carbon-neutral and environment-friendly, and therefore, it decreases the emission of greenhouse gases. As biofuel is carbon-neutral, it does not add CO_2 to the atmosphere and has been supported with lifecycle analysis. The analysis shows that biofuel emits less greenhouse gases than fossil fuels like petroleum and diesel. Ethanol produces 13% less greenhouse gases than fossil fuels (Science Daily, 2007) and biodiesel

can reduce carbon emissions by 78% (United States Agency for International Development). Ethanol was found to have a 21% reduction in CO_2 equivalent production in comparison to 2.44 kg CO_2 equivalent/liter production from gasoline. The reduction in greenhouse gas emission is larger with lignocellulosic ethanol than for starch-derived ethanol due to the lower overall oil input required in the process. Table 1 indicates the reduction in emissions.

Food shortage, soaring prices

Most of the nations in the world are dependent on food imports. Cereal surpluses are produced only in those countries that have relatively low population densities and practice intensive agriculture. For instance, the US (United States), Canada, Australia, Oceania, and Argentina provide 81% of the net cereal exports in the world market. The per capita availability of world grains, which makes up 80% of the world's food, has been declining for the past 15 years and food prices will increase by 20%–40% in the next decade. To ensure smooth implementation of the Energy Independence and Security Act, mandating an increase in corn ethanol production to 15 billion gallons by 2015 and 36 billion gallons by 2022, the US government has promised a subsidy of $0.51 per gallon of corn ethanol. This will inevitably cut back on market supply of corn and push the already inflated prices higher. Also, there are concerns regarding the shifting of cropping pattern of the farmers in some developed countries from food grains to crops being used for biofuels. Farmers are shifting to the cultivation of crops which are used for the production of biofuels, decreasing the area under food grains. This creates gaps between the demand and supply of food grains. The use of corn for ethanol production and their demand for soya bean oil has increased world food prices by about 10%, according to an International Monetary Fund report.

Table 1 Reduction in pollution emission with different percentages of ethanol blending

Pollutant	Emission (%)		Emission (g/km)	
	10% ethanol blend	15 % ethanol blend	22% ethanol blend	100 % ethanol blend
Particulate matter	27	41	0.08	0.02
NOx	4	5	0.45	0.34
Carbon monoxide	20	27	0.76	0.65
Unburned hydrocarbons	–	–	0.004	0.02
Sulphur dioxide	–	–	0.064	0.0

But the so-called 'food versus fuel' controversy appears to have been exaggerated in many cases. The subject is far more complex than has generally been presented, as agricultural and export policies and the politics of food availability are factors of far greater importance. The argument should be analysed against the background of the world's or an individual country's real food situation of food supply and demand, the use of food as animal feed, the under-utilized agricultural production potential, the increased potential for agricultural productivity, and the advantages and disadvantages of producing biofuels. The specific aims of food security ensures production of adequate food supplies, maximizing stability in the flow of supplies and securing access to available supplies on the part of those who need them.

It is estimated that the country will need about 260–264 Mt of food grains, 130–150 Mt of vegetables, 80–106 Mt of fruits, 10–14 Mt of meat, 35 billion eggs, 10–14 Mt of fish, and 12 Mt of edible oils to provide adequate nutrition to 1.35 billion people by 2020. India achieved food self-sufficiency 30 years ago through dramatic investments in technology, institutions, and infrastructure. In 1952/53, the total food production was 59.2 Mt. While 102.09 million hectares was used for food grain production, the yield was only 580 kg per hectare (Fig1). By 2007/08, 122.4 million hectares were covered and food production increased to 230.7 Mt with a productivity of 1854 kg/ha.

India is well-placed in meeting the challenge of food security. It is one of

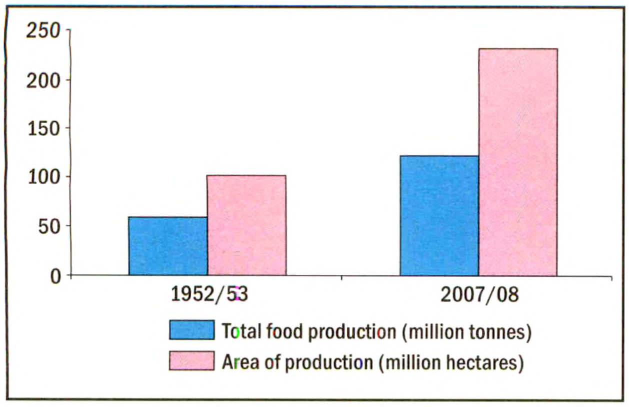

Figure 1 Area and production of food grains over decades

the largest producers of food grains in the world, feeding 17% of the world population on only world's 3% of arable land. It is the second largest producer of wheat and rice in the world, growing 12%–22% of the world's total wheat and rice crop, respectively. The country has food management initiatives like procurement of food grain from farmers at remunerative prices, distribution of food grains to the consumers particularly the vulnerable sections of the society, and maintaining a buffer stock of food gains to ensure food security. The Food Corporation of India, the biggest buyer of grains, bought a record 233 lakh tonnes of wheat and 291 lakh tonnes of rice last year, which should suffice for two years according to the officials. Our food grain buffer stock is enough to feed our people for 13 months. In the beginning of 2009, there were 180.6 lakh tonnes of wheat in the central government's pool, which is more than twice the buffer stock requirement of 82 lakh tonnes. Similarly, there was 173.4 lakh tonnes of rice, which is greater than the buffer stock requirement of 118 lakh tonnes. Rice and wheat are two food grains whose production growth determines India's capacity to feed itself. The total food grain stock stood at 354 lakh tonnes, which is way above the buffer stock requirement of 200 lakh tonnes.

However, despite the huge stockpile, there are thousands of people who are not able to buy the food grains offered at subsidized rates through the government outlets. Yet, in some of the regions, improper storage and lack of proper distribution system has led to people going hungry and even facing starvation deaths. There is a need for both short- and long-term policy to meet the emerging surplus situation to solve the problems of excess stock and acute shortage of storage space, and levy carrying costs, while ensuring effective price support to farmers. Food insecurity exists when people are under-nourished as a result of the physical unavailability of food, the lack of social or economic access to adequate food, and/or inadequate food utilization. The population and per capita availability of food grains over years are given in Table 2.

Table 2 Population and per capita per day net availability of food grains

Year	Population (million)	Per capita net availability per day (gm)		
		Cereals	Pulses	Total
1952	369.2	325.4	59.1	384.5
1962	452.2	398.9	62.2	460.9
1972	563.9	419.1	47.0	466.1
1982	703.8	415.6	39.2	454.8
1992	867.8	434.5	34.3	468.8
2002	1050.6	458.7	35.4	494.1
2003	1068.2	408.5	29.1	437.6
2004	1085.6	426.9	35.8	462.7
2005	1102.8	390.9	31.5	422.4
2006	1119.8	412.8	32.5	445.3
2007	1136.5	407.4	35.5	442.8

Source Economic Survey 2008/09

Food Security

The government has been implementing a wide range of nutrition intervention programmes for achieving food security at the household and individual levels. The PDS (Public Distribution System) supplies food items, such as food grains and sugar, at administered prices through fair price shops. There have been a range of food-for-work and other wage employment programmes. Another approach adopted by the government is to target women and children directly. This includes mid-day meal programme for school-going children and supplementary nutrition programme for children and women; ICDS (Integrated Child Development Scheme) for providing nutrition and healthcare services to children and pregnant women; and the Antyodaya Anna Yojana for providing affordable food to BPL (below poverty line) households. The proposed NFSA (National Food Security Act) may be an important step towards eradicating hunger and reducing malnutrition in the country. Implementation of this act will ensure that every BPL cardholder gets 25 kg

of either rice or wheat at Rs 3 per kg every month.

Biofuel production in India

India does not produce any ethanol from cereal grains, and thus, there has been no impact of the ethanol programme on the domestic market for food, feed, and trade of cereal grains and byproducts. As the production of ethanol for fuel is basically from sugar molasses, it has not had a significant impact on the production, prices, and trade of sugar for food and industrial use. Despite a decline in the production of sugarcane/sugar and consequently, sugar molasses, higher prices of alcohol vis-à-vis fixed ethanol prices have limited fuel ethanol production. If ethanol prices are allowed to be linked to sugar molasses prices, it may impact the availability of sugar molasses for use in cattle feed and the use of alcohol for industrial and potable liquor. When Stage III of the EBP (ethanol blending programme) is implemented, it may also impact the availability of sugarcane juice and sugar molasses for alternative uses.

India has about 320 distilleries, with a production capacity of about 3.5 billion litres of rectified spirits (alcohol) per year, almost all of which is produced from sugar molasses, and not from sugar juice, food grains, or other cellulose feed stocks. More than 115 distilleries modified their distillation facilities to produce ethanol, with a total ethanol production capacity of 1.5 billion litres per year. Current ethanol production capacity is enough to meet the estimated ethanol demand for the 5% blending ratio with gasoline. However, for a 10% EBP, current ethanol production capacity has to be expanded by increasing the number of molasses-based ethanol plants and by setting up sugarcane juice-based ethanol production units.

Table 3 Total crop residue production and their availability for ethanol production in India

Crop	Total residue production (Mt air dry weight)		Non fodder crop residues (Mt air dry weight)	
	1996/97	2010	1996/97	2010
Rice	146.5	213.9	26.7	41.0
Wheat	110.6	157.6	8.8	21.4
Jowar	22.3	12.2	—	—
Bajra	15.8	13.6	0.0	1.4
Maize	26.3	32.5	5.3	—
Other cereals	9.4	2.8	—	—
Red gram	13.5	11.2	13.5	11.2
Gram	9.3	13.5	9.3	13.5
Other pulses	17.1	17.1	17.1	16.5
Groundnut	20.7	28.1	20.7	28.1
Rapeseed and mustard	13.8	24.1	13.8	24.1
Other oilseeds	18.2	27.1	18.2	27.1
Cotton	50.0	55.7	50.0	55.7
Jute	15.7	10.5	15.7	5.9
Sugarcane	110.8	185.4	99.7	163.5
Coconut and Arecanut	20.0	28.2	20.0	28.2
Mulberry	3.0	3.3	3.0	3.3
Coffee	3.42	3.9	3.4	3.9
Total	626.5	840.6	325.3	450.7

storage-related characteristics, storage facility, and other such factors.

Jatrapha plant

Potential of crop residues as feedstock for ethanol

Crop residues have 30%–35% cellulose, 20%–35% hemicellulose, and 15%–20% lignin, which could be used for fuel production. About 73.9 Tg (teragram) per year of dry wasted crops and 1.5 Pg (pentagram) per year of dry lignocellulosic biomass from seven common crops in the world could potentially produce 49.1 GL (giga litre) per year and 442 GL per year of bioethanol, respectively, leading to a total production of 491 GL per year. The major crop residues produced in India are straws of paddy, wheat, millet, sorghum, pulses, oilseed crops; maize stalks and cobs; cotton stalks; jute sticks; sugar cane trash; mustard stalks; and so on. Some past and future projected data for various agro-residues at the national level are given in Table 3. The total crop residue production during 1996/97 is estimated to be 626 Mt. The dominant residues are those of rice, wheat, sugarcane, and cotton, accounting for 66% of the total residue production.

Sugarcane and cotton residue production is 110.8 Mt and 50.0 Mt, respectively. As 390 Mt of crop residues, which are used as fodder, will not be available as feedstock for energy in the year 2010, the total potential of non-fodder crop residues available for energy is estimated to be 325 Mt and 450 Mt for 1996/1997 and 2010, respectively [Table 3]. India has the potential to produce around 713 million gallons of bioethanol annually, in comparison to its present production of 4% to the world total production. Besides this, a portion of the agri-residues (rice straw, wheat straw, corn stover, and so on) that are presently burnt or left in the field due to mechanized farming may also be harvested for bioethanol production. The crop residues are available throughout the year and dependency on a single feedstock is, hence, not required. The amount available depends upon the harvesting time, storage-related characteristics, storage facility, and other such factors.

'Smart' biofuel crops ensure food and environmental security

The 'smart' biofuel crops developed, utilized, and promoted by the ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), Patancheru, Andhra Pradesh, ensure energy and environmental security. Smart biofuel crops are those that ensure food security, contribute to energy security, provide environmental sustainability, tolerate the impacts of climate change on shortage of water and high temperatures, and increase livelihood options. ICRISAT-bred sweet sorghum varieties and hybrids have increased sugar content in their stalks. It has a strong pro-poor advantage, as it has a triple product potential—grain, juice for ethanol, and bagasse (waste) for livestock feed and power generation. Its highlight is that there is no compromise on farmers' food security, since the grain is available for the farmers, along with sugar-rich juice from the stalk that can be distilled to manufacture ethanol.

Biofuel from non-edible oils

As the biodiesel programme is based on the use of non-edible vegetable oil, biodiesel production should not have an impact on feed, food, and trade of oilseeds, vegetable oils, and other edible products. Biodiesel production efforts are focused on using non-edible oils from plants (*Jatropha curcas*, *Pongamia pinnata*, and other tree-borne oilseeds) and animal fats like fish oil. The focus is to encourage the use of wastelands and other unproductive land for the cultivation of these relatively hardy 'new' biofuel crops. The GOI (Government of India) does not want biofuel feedstock crop cultivation to compete with food crops for scarce agricultural land and water. An estimated 55.3 million hectares are considered wasteland in India, which could be brought into productive use by raising biodiesel crops. The GOI policy is also driven by the fact that biofuel crop cultivation in wastelands would provide additional employment to the vast rural population in India.

In April 2003, the GOI launched a National Mission on biodiesel that identified Jatropha curcas as the most suitable tree-borne oilseed for the production of biodiesel, and focused on promoting plantations of Jatropha on 'wastelands'. The Planning Commission set an ambitious target of 11.2-13.4 million hectares to be planted with Jatropha by 2012, in order to produce sufficient biodiesel to blend at 20% with petro-diesel. According to Dr Abdul Kalam, former President of India, out of the 600 000 sq km of wasteland that is available in India, over 300 000 sq km is suitable for Jatropha cultivation. Indian Railways has already taken a significant step of running two passenger locomotives (Thanjavur to Nagore section) and six trains of diesel multiple units (Tiruchirapalli to Lalgudi, Dindigul, and Karur sections) with a 5% blend of biofuel sourced from its in-house esterification plants. The Reliance Industries has selected 200 acres (0.81 sq km) of land at Kakinada in Andhra Pradesh to grow Jatropha for high quality biofuel. Chhattisgarh has decided to plant 160 million saplings of Jatropha in all its 16 districts during 2006 with the aim of becoming a biofuel self-reliant state by 2015. Farmers of Karnataka, Tamil Nadu, Rajasthan, and Maharashtra have also planted Jatropha to produce biodiesel.

However, Jatropha suffers from certain limiting factors such as the non-availability of high-yielding Jatropha saplings to the grower, low yield on marginal land, and land availability. But the real challenge lies in the efficiency and cost effectiveness of the technology that requires focused R&D and governmental policies. If right species and right plantation materials are selected and the right agronomic practices are adopted, the results might be profitable, viable, and sustainable.

Conclusion

Biofuels are considered to be the most important option for energy security and environmental protection from greenhouse gas emissions. The diversion of grain and oilseed crops from dinner tables to fuel tanks imbalances the food security. So it is a challenge to the scientific community to develop an integrated approach for energy production without compromising on our feed priority.

Inviting articles for Akshay Urja

The need to have a sustainable supply necessitates the exploitation of available energy sources, and among these, renewable resources are at the forefront. It is now an established fact that RE (renewable energy) can be an integral part of sustainable development because of its inexhaustible nature and environment-friendly features. RE can play an important role in resolving the energy crisis in urban areas to a great extent. Today RE is an established sector with a variety of systems and devices available for meeting the energy demand of urban inhabitants, but there is a need to create mass awareness about their adoption. *Akshay Urja* is an attempt to fulfil this need. 20 000 copies are being disseminated in India and abroad.

Akshay Urja publishes news, articles, research papers, case studies, success stories, and write-ups on RE. Readers are invited to send material with original photographs and statistical data. The photographs should be provided on hard copy or as high resolution (minimum 300 DPI) files on a CD. *Akshay Urja* will pay suitable honorarium for each published article of about 1500 words and above to the authors. The publication material in two copies, along with a soft copy on CD/floppy/e-mail may be sent to

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Green initiative by the Himachal Pradesh government

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चार दिन में पायरिया जड़ से खत्म
प्राक्
पायरिया दन्त मंजन
मर्दाना कमजोरी व ताकत के लिये
प्राक् एनर्जी प्लस
खूनी एवं बादी बावासीर के लिये
प्राक्

In 2008, when the HP (Himachal Pradesh) government announced the free distribution of 64 lakh power-saving CFLs (compact fluorescent lamp) to all its domestic consumers, most people read a political motive behind it. But, it was a pure and simple business for the state government that would profit everybody and prove to be win-win to all. From the end domestic consumers to the state exchequer, everybody is at an advantageous position.

The Bijli Bachat Yojna probably made it the first state in the entire South East Asia region to successfully replace all domestic electricity-guzzling incandescent bulbs with power-saving CFLs. A small decision, which costed just about Rs 70 crores, proved to be one of the most profitable 'green' business decisions taken by the state government in the past two years.

While it gave free CFLs to all domestic consumers, it gave additional revenue of Rs 99 crores to the government. Also, the HPSEB (Himachal Pradesh State Electricity Board) would also be able to lessen its burden of transmission and distribution, and improve its power quality in remote areas. It also indirectly helped to reduce emission of greenhouse gases because of less consumption of power. A rough estimate made by the state government claimed that the decision would prevent an annual emission of carbon dioxide to the tune of 188 496 tonnes and might earn 188 496 CERs (Certified Emission Reductions), which is worth Rs 20 crores on selling the CERs in the international market. And the saving of 75 to 150 MW (megawatt) of power during peak hours would save an investment of nearly Rs 420 crores, which was otherwise required to build the power generation capacity of the state.

The green decision

The 'green' scheme, named Atal Bijli Bachat Yojna, provided every consumer with four CFLs – two 15-watt and two 20-watt – free-of-cost, as a replacement of two 60-watt and two 100-watt incandescent lamps at a premises. The state received overwhelming response and within a few months, the CFLs were distributed all over the states. The state government also ensured its consumers that it would replace all the defective CFLs within 18 months of distribution. The feedback it received was quiet impressive.

Energy bills of the consumers reduced by 25%–30%, depending upon the usage pattern of the consumers and the number of electric gadgets being used. It would have been a profitable venture for consumers even if the state government had not distributed the CFLs for free. While the cost of CFLs is 5–10 times higher than incandescent bulbs, it consumes 4–5 times less power and has 6–7 times more shelf life. The consumers would be benefitted and compensated in the long run by the savings in the huge electricity bills. 'We are now also able to provide better quality electricity to rural consumers, since the overall voltage has improved due to reduction in load,' said S K Choudhary, member secretary HPSEB.

Power advantage

It is estimated that the scheme contributed to a saving of 270 million units of electricity, annually. This helped the HPSEB to earn five times more revenue. The replacement of CFLs saved approximately 115 MW of energy for six hours on a daily basis. The maximum demand on the system was reduced by 75–150 MW during the peak hours, which was made available to other consumers who were paying almost five times more than the domestic consumers. 'You can calculate the addition of earning to the state revenue from the fact that we sell one unit of power to domestic consumer at 80 paise, whereas during peak hours in summers, the same power is sold to other states at as high as Rs 7.50 per unit. Energy we saved is energy we generated,' said the State Power Secretary, Mr Deepak Sanan. The state government says that the present trend shows that the state exchequer would earn additional annual revenue of Rs 99 crores by selling the saved energy.

Investment advantage

The one-year experiment with CFLs has revealed that the replacement of conventional bulbs is equivalent to the installation of one hydel project of 70 MW capacity. It would avoid investment of about Rs 420 crores. 'Indirectly, it means that the state government had to invest only Rs 70 crores to save investment of Rs 420 crores on account of building power generation capacity. Moreover, by investing Rs 70 crores, the state government is expected to fetch additional annual revenue of Rs 99 crores,' said a senior officer of the HPSEB.

Carbon trading advantage

The project is the first major effort of the state government to earn resources through carbon trading. The scheme qualifies for earning through CERs under the CDM (Clean Development Mechanism). CERs are also called carbon credits. One CER is equivalent to reduction of one tonne of carbon dioxide or equivalent greenhouse gases from the environment. It is issued by the Executive Board of the UNFCCC (United Nations Framework Convention on Climate Change) for emission reduction achieved by CDM projects and verified by a DOE (department of energy) under the rules of the Kyoto Protocol. The CERs are purchased by the developed countries in order to comply with their emission reduction targets or by operators of installations covered by the European Union Emission Trading Scheme. The HPSEB has already initiated the process for acquiring the approval of the CDM Executive Board of the UNFCCC. If all goes well, the HPSEB would be entitled for an estimated 188 496 CERs, which might fetch revenue to the tune of Rs 20 crores at the present rate.

Just a beginning...

The successful implementation of the Bijli Bachat Yojna is just the beginning of power-saving experiments by HP. 'We are now replacing traditional bulbs with CFLs in government buildings and educational institutions. The state government is further planning to give incentives to commercial and industrial houses to use power-saving gadgets. The announcement would come soon, and we would issue guidelines and provisions for industrial houses,' said Choudhary. In another move, the state government would start a pilot project to replace traditional streetlights with LEDs (light emitting diodes). 'LEDs are more rough and tough, and more power-efficient than even CFLs. First, the pilot project would be confined to a few municipal areas and subsequently, it would spread to all municipal areas in the state,' said Choudhary.

Chief Minister of West Bengal inaugurates SPV module manufacturing plant of Vikram Group of Industries at Falta SEZ

Buddhadeb Bhattacharya, Chief Minister of West Bengal, inaugurating the SPV module manufacturing plant of Vikram Group of Industries.

On 10 March 2010, Buddhadeb Bhattacharya, Chief Minister of West Bengal, inaugurated the SPV (solar photovoltaic) Module Manufacturing Plant of Vikram Group of Industries at Falta SEZ (Special Economic Zone). 'Vikram Solar has invested about Rs 100 crores in this project, with an initial capacity of 25 MW (megawatt) per annum. We are already in the process of expanding its capacity to 50 MW by the middle of this year', says H K Chaudhary, Chairman, Vikram Group of Industries.

The establishment of this solar plant is expected to provide the masses green and clean energy, making solar industry the backbone of the Indian economy in the near future.Vikram Solar has already provided employment to more than 100 people. Once the full expansion is implemented, more than 800 people would be provided employment, directly and indirectly, with a focus on skill development and training in the high technology solar industry.

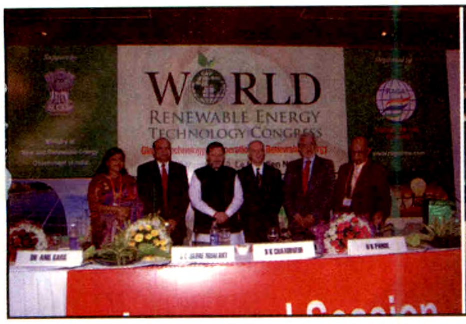
To deliver solar power to non-grid areas, Vikram Solar has initiated a R&D (research and development) project in collaboration with BESU (Bengal Engineering and Science University) for applied research in the field of long-life solar battery systems to sustain a lifecycle of 15–20 years, as compared to the current life of 3–5 years. This initiative has been taken up under the MNRE (Ministry of New and Renewable Energy) research proposals for the development and demonstration of electricity storage systems. The event was attended by Debesh Das, Minister-in-Charge of the Department of Information Technology, Government of West Bengal; and S P Gon Choudhuri, Managing Director, West Bengal Green Energy Development Corporation Ltd; Arun Bit, Development Commissioner, Falta; Khalil Ahmed, Deputy Manager, South 24 Parganas; Chandana Ghosh Dastidar, Member of Legislative Assembly, Falta; and other dignitaries and industrialists.

World Renewable Energy Technology Congress

Global technology cooperation for renewable energy

The World Renewable Energy Technology Congress and Exhibition-2010 was held at Hotel Le Meridien, New Delhi, from 18–20 March 2010. The congress was organized by RAGA Integrated Technology Management Services, and inaugurated by B K Chaturvedi, Member, Planning Commission of India. It was attended by 410 delegates, dignitaries, and speakers from 30 countries. The exhibition of green technology, services, equipment, and know-how of various renewable energy sectors was inaugurated by Her Excellency Daniele Smadja, Ambassador, Head of Delegation of European Union. During the three-day conference, theme, keynote, and technical sessions were conducted to exchange ideas and discuss technology development to improve efficiency and future technology development in the various segments of renewable energy. The role of renewable energy today and tomorrow was also discussed, along with climate change and green power programmes.

Some of the eminent speakers were Deepak Gupta, Secretary, MNRE; B M Bansal, Chairman, Indian Oil Corporation Ltd; Dr Pramod Deo, Chairman, Central Electricity Regulatory Commission; Dr Ajay Mathur, Director-General, Bureau



of Energy Efficiency; Mark Ginsberg, Senior Executive Board Member, United States Department of Energy.

Gauri Singh, Joint Secretary, MNRE; Dr N P Singh, Advisor, MNRE; Dr A R Shukla, Scientist-G/Advisor, MNRE; Dr Bibek Bandyopadhyay, Director, Solar Energy Centre, MNRE; and Dr Ahmar Raza, Director, MNRE, chaired various technical sessions. The participants enjoyed the glimpses of traditional dances of India, the taste of Indian food, and the cultural programmes on the second day of the congress.

The congress was concluded, with support from various sponsors and compliments from the participants. A common view emerged— 'promotion of renewable energy sources and technologies is one of the crucial strategies to bridge the demand–supply gap in the power sector in an environmentally sustainable and benign manner. It can also pave the way for strategic shift from future dependence on the import of fossils fuels and enhance the contribution of renewable energy in the energy mix, leading to enhanced energy security—a step forward towards the "Energy Independence of India".'

During the valedictory session, a joint declaration was signed by eminent personalities from the US, Australia, Germany, and India on behalf of all participants. Few of the important resolutions are as follows.

- Making solar energy competitive in India by 2020.
- Formation of permanent society for holistic development of renewable energy and green technologies.
- The world green technology community to assemble again from 21–23 April 2011 for the Second WRETC and Exhibition in New Delhi.

A 'sun'day interaction with RWA one solar energy

ORGANISES
ORIENTATION CUM TRAINING PROGRAM
FOR
RESIDENT WELFARE ASSOCIATIONS
FUNDED BY
MINISTRY OF NEW AND RENEWABLE ENERGY
GOVERNMENT OF INDIA

The National Power Training Institute (NPTI) organized a close-group interaction with Resident Welfare Association (RWA) Vasundhara, Delhi, on rooftop solar power system and community-level applications of solar energy on 25 April 2010. The aim was to instill confidence; encourage and elicit direct response from the end-user community; and raise their interest in solar photovoltaic (SPV) and solar water heating systems (SWHS). The event included live demonstration of solar power panels, charge controllers, battery, solar fan, and lighting interconnection setup and various techno-commercial aspects of the support schemes from the MNRE and the state governments.

The programme was chaired by Dr N S Saxena, Director General, NPTI, and was attended by eminent personalities like S K Sharma, President of the RWA federation; Dr P C Pant and Dr Arun K Tripathi, Directors, MNRE; R K Sharma, Principal Director, NPTI(N R), and the residents of Vasundhara Society. It was an initiative of Sandeep Dixit, Assistant Director and Faculty at NPTI.

While R K Sharma highlighted the significance of such interactions, Dr Saxena talked about the importance of SPV systems, despite the initial high cost. Dr Pant and Dr Tripathi talked about the renewable energy developmental activities; applications; and the subsidy and support schemes of the MNRE. The various queries of the participants, relating to the cost, development of specifications, warranty, life, aging, and space requirements of systems, were also clarified. S K Sharma assured full support and cooperation in taking up system studies covering the society needs.

MAKE A SOLAR DISTILLER

Imagine you are stuck on a deserted island, without even a drop of water! All you can see around you is either the salty seawater or some muddy water in the interiors. How will you survive? Well, if you have the following materials, you can make a solar water distiller!

Materials

- Two large plastic containers
- Clear plastic wrap
- Masking tape
- Two small rocks
- Two small glasses
- Muddy/salty water

Procedure

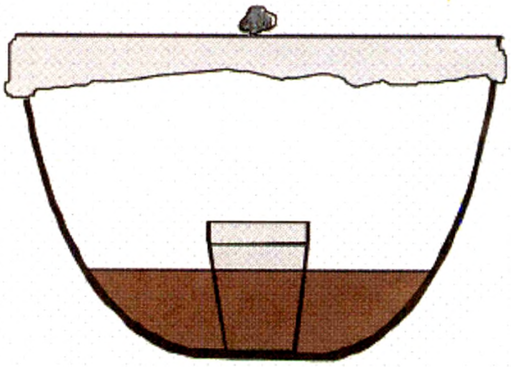
- Fill both the plastic containers with one inch of the muddy/salty water.
- Place one empty glass in an upright position into the middle of each plastic container. Make sure it remains empty.
- Cover both plastic containers tightly with plastic wrap and seal them with the tape.
- Place a small rock in the middle of the plastic wrap, directly over the glass but not touching it.
- Place the stills in a sunny place for two hours.

Now go about your other survival activities, like procuring food and shelter. The distiller will make about 1 litre a day in 12 hours of sunshine, if your container is big enough. It may not be much, but it will sustain a person for quite a while. And you might be able to replicate several distillers if you are able to find enough equipment. Putting the apparatus over a fire/stove, if it is available, will make the production much faster. But in a survival situation, do weigh the fuel cost versus the benefits of doing so.

How it works?

Solar distillers work by mimicking the natural water cycle. The sun provides energy to warm the water, the water evaporates (forms clouds), and finally, condenses when it meets a cooler surface (makes rain).

Distillation utilizes the principle that chemicals vapourize at different temperatures. Most contaminants in water have vapourization points that are higher than that of water. A simple solar distiller removes salts, heavy metals, bacteria, arsenic, and many other contaminants. When untreated water is heated in a solar distiller, pure water vapourizes first, leaving contaminants behind.



Send in your answers to the following address. The first three correct entries will be published in the next issue of *Akshay Urja*.

The Editor, *Akshay Urja,* Room No. 1009A, 10th Floor, Paryavaran Bhavan, CGO Complex

Lodhi Road, New Delhi – 110 003, E-mail aktripathi@nic.in or suparna.mukherji@teri.res.in

UNDERSTANDING CARBON CREDITS

Are you confused about the carbon industry? Do you need help to understand the basics and how it all works? Do you know the difference between carbon credits, offsets, and permits? Would you like to know more about the carbon industry but do not know where to start? Then you need a copy of *Understanding Carbon Credits* to help you understand the industry better and how it all works.

This book has been written to help individuals, businesses, and organizations to understand the basics of carbon trading, carbon credits, and the emerging carbon market in a simple, concise, and informative document. It has been written in a simple, laymen's language, unlike a lot of the current industry books that are filled with jargon that are currently being used.

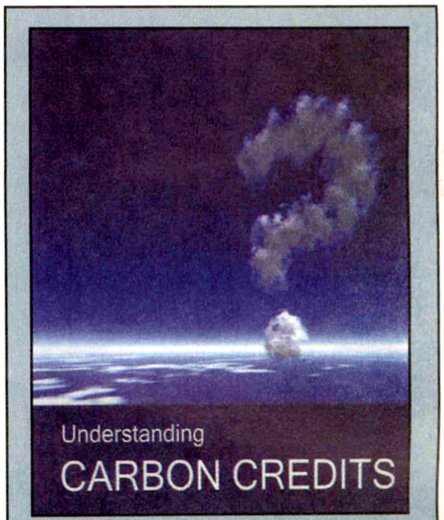
After reading this book, you will be confident to talk about the basics of carbon trading and carbon credits with anyone in the industry. It will also help you to decide about what you should and can do next. You will be in a better position to make informed decisions about the marketplace and figure out if carbon trading is right for you.

There is an urgent need to understand global warming and the tipping points for dangerous impacts that we have already crossed as a sustainability emergency, which takes us beyond the politics of failure-inducing compromise. We are now in a race between climate tipping points and political tipping points. As the threats posed by global warming become more obvious, not only to scientists but also to the general public, the concept of being able to go 'carbon neutral' is an attractive one. Carbon neutrality offers individuals, businesses, and other institutions like universities the opportunity to take personal responsibility for the global warming implications of their lifestyles.

With global emissions of carbon dioxide exceeding 25 billion tonnes per year and growing, it will take radical changes in energy production and use to avoid the 'dangerous anthropogenic interference' with the climate system that the United Nations Framework Convention on Climate Change warns against. National and international policies will be pivotal to any successful long-term effort to reduce GHG (greenhouse gas) emissions and to moderate global warming. At the same time and, partially, in response to the absence of such policy, voluntary GHG markets are proliferating.

This book presents the writing of Gurmit Singh, a research scientist in climate change-related damage to global ecosystems and the resulting competition for natural resources, with regard to the pressing environmental issues of today. He has a persistent clarity of vision of a future where human beings transform their greed into a profound respect for nature.

Interest in carbon offsets has grown dramatically in the last few years. The New Oxford American Dictionary even chose 'carbon neutral' as its 'Word of the Year'! This is a clear evidence of the fact that this is the wave of the present and that understanding offsets and the role they play in attaining 'carbon neutrality' is increasingly important.


Understanding
CARBON CREDITS

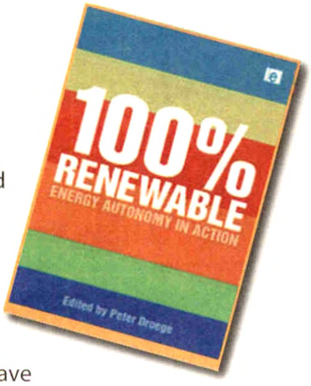
Singh G. 2010
India: Aditya Books, 466 pp.
ISBN: 8185353611
Price: Rs 1795

The cap-and-trade system is one of the most sophisticated and comprehensive methods of combating global warming. Despite being an environmental issue, it has integral financial and economic aspects. Cap-and-trade is a policy that aims to limit GHG emissions by requiring certain industries to buy carbon offsets if emissions exceed the legal cap.

Carbon trading is carefully regulated in developed countries that signed the Kyoto Protocol. But so far, the offset market in the United States has been voluntary and free from any industry-wide oversight or standards for certification, projects, or business models. However, those days may be numbered.

This book is a comprehensive and accessible guide to understand the opportunities offered by regulated and voluntary carbon markets for tackling climate change. Combining theoretical aspects with practical applications, this book is for business leaders, financiers, carbon traders, lawyers, bankers, researchers, policy makers, and anyone who is interested in market mechanisms to mitigate climate change.

100 PER CENT RENEWABLE: ENERGY AUTONOMY IN ACTION



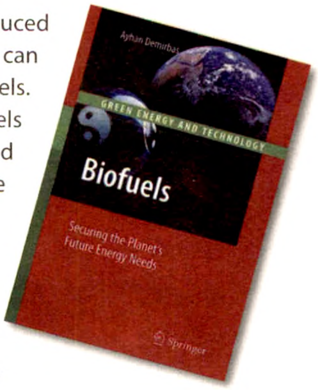
Edited by Peter Droege.2009
UK: Earthscan

The greatest challenge of our time is to build a world based on the sustainable use of renewable power. A 100% renewable world is seen by many as an impossible dream in anything but the very long term. But not only do a growing number of initiatives and plans dare to make the change but many have already achieved it.

This rich collection presents a series of pioneering efforts and their champions, and the paths to their successes. Ranging from initiatives by individuals to visions for companies, communities, and entire countries, it defeats tired economic and technical counter-arguments, showing how the schemes featured not only can and do work but do so economically and with available technology. The book is introduced by incisive writing by Peter Droege, explaining the challenges and framing a roadmap towards a 100% renewable reality.

ISBN: 978-1-844-07718-2 • Price: £35.00

BIOFUELS: SECURING THE PLANET'S FUTURE ENERGY NEEDS


Ayhan Demirbas
GREEN ENERGY AND TECHNOLOGY
Biofuels
Securing the Planet's Future Energy Needs
Springer

Edited by Ayhan Demirbas.2009
UK/US: Springer

Biofuel is a renewable energy source produced from natural (bio-based) materials, which can be used as a substitute for petroleum fuels. The benefits of biofuels over traditional fuels include greater energy security, reduced environmental impact, foreign exchange savings, and socioeconomic issues related to the rural sector. And the technology is relevant to both developing and industrialized countries. For these reasons, the share of biofuels in the automotive fuel market is expected to grow rapidly over the next decade.

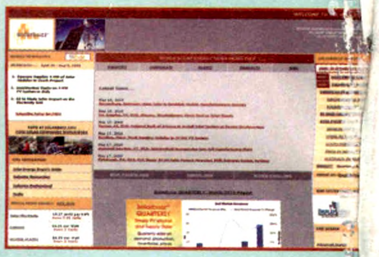
The most common biofuels, such as ethanol from corn, wheat, or sugar beet and biodiesel from oil seeds, are produced from classic food crops that require high-quality agricultural land for growth. However, production of bioethanol from biomass is one way to reduce both the consumption of crude oil and environmental pollution. There is also a growing interest in the use of vegetable oils for making biodiesel, which is less polluting than conventional petroleum diesel fuel.

The book, one of the series Green Energy and Technology, discusses options for the production of transportation fuels from biomass (such as wood, straw, and even household waste). The book is an important text for undergraduates, postgraduates and researchers in energy engineering, as well as professional fuel engineers.

ISBN 978-1-848-82010-4 • Price: £81.00

Internet resources ▸▸▸

SOLAR BUZZ


www.solarbuzz

Solarbuzz is an international solar energy research and consulting company, staffed with a team drawn from some of the largest companies in the solar energy industry today. Its Solarbuzz.com is a portal on solar energy, through which you can access Solarbuzz rese reports and consultancy services, follow global solar market and supply developments, and connect to so energy companies worldwide.

The portal gives links to companies and topics re to the solar industry. While the primary focus of the s content is photovoltaics (solar electric), it also includes companies in our listing that market solar thermal syst Solarbuzz.com also maintains on-site content, so that users can receive a speedy understanding of both the commercial and environmental potential of solar ene Potential purchasers of solar energy and products can the country pages, which not only provide informatio the closest solar companies, but you can also gain valuable information regarding how to get the best o solar power.

EUROPEAN BIOFUELS TECHNOLOGY PLATFORM

www.biofuelst

The European Biofuels Technology Platform is a common interest group that aims to promote the development of biofuels for transport in Europe. It is supported by a secretariat th receives some funding from the European Commissio under the Sixth Framework Programme. The project aims to facilitate the entry of European manufactures sustainable energy technologies, know-how and European research results into the emerging markets, provoked by the European Union Emission Trade Scheme, and Cle Development Mechanism markets in Asia. The main t are information dissemination, project brokerage, an partnering events. Additionally, this website provides details of good practice, technology, and service provi and background information.

National

Green Energy World Expo 2010
14–16 October 2010
Chennai, India
E-mail: daisy@gsnaworldwide.com
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URL: www.direc2010.gov.in

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Fax: 62 21 865096-3
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URL: www.rainer-timpe.de

25th European Photovoltaic Solar Energy Conference
6–10 September 2010
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Tel: 49 89 720 12 735
Fax: 49 89 720 12 791
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PV Rome Mediterranean
9–11 September 2010
Rome, Italy
Tel: 39 02 6630 6866
E-mail: info@zeroemission.eu
URL: www.zeroemission.eu

4th International Solar Cities Initiative (ISCI) Congress 2010
16–19 September 2010
Dezhou, China
Tel: 86 534 22396-29
Fax: 86 534 22396-17
E-mail: jwsjk@sina.com
URL: www.chinasolarcity.cn

12th Renewable Energy Finance Forum-London
20–21 September 2010
London, United Kingdom
Tel: 44 207 779 8995
Fax: 44 207 779 8946
E-mail: energyevents@euromoneyplc.com
URL: www.euromoneyenergy.com

World Renewable Energy Congress XI and Exhibition
25–30 September 2010
Abu Dhabi, United Arab Emirates
Tel: 44 1273 625643
Fax: 44 1273 625768
E-mail: asayigh@netcomuk.co.uk
URL: www.wrenuk.co.uk/wrecxi.html

2nd International Photovoltaic Solar Energy
27–29 September 2010
Beijing, China
Tel: 86 10 87194-788
Fax: 86 10 87194-417
E-mail: ipvsee@solarpromotion.org
URL: www.ipvsee.com

3rd Renewable Energy Finance Forum - West
28–29 September 2010
San Francisco, California, US
Tel: 44 207 779 8995
Fax: 44 207 779 8946
E-mail: energyevents@euromoneyplc.com
URL: www.euromoneyenergy.com

Solar Power 2010
12–14 October 2010
Los Angeles, California, US
Tel: 1 202 857 0898
Fax: 1 202 682 0559
E-mail: info@solarelectricpower.org
URL: www.solarelectricpower.org

4th POWER Bangladesh 2010
14–16 October 2010
Dhaka, Bangladesh
Tel: 1 347 543 5543
Fax: 1 347 242 2657
E-mail: cems@cemsonline.com
URL: pv-expo.net

Solar Industry Conference (CIS-ES)
21–22 October 2010
Madrid, Spain
Tel: 49 30 72629630-0
Fax: 49 30 72629630-9
E-mail: info@solarpraxis.de
URL: www.solarpraxis.de

5th International Exhibition Energy-Photovoltaic 2010
21–24 October 2010
Athens, Greece
Tel: 30 210 6141164
Fax: 30 210 8024267
E-mail: info@leaderexpo.gr
URL: www.leaderexpo.gr

PV Taiwan 2010
26–28 October 2010
Taipei, Taiwan
Tel: 886 2 2725 5200
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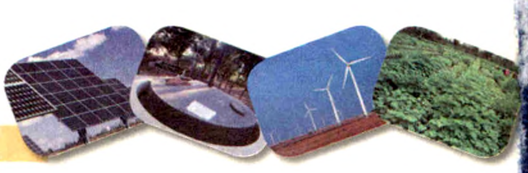
E-mail: pv@taitra.org.tw
URL: www.pvtaiwan.com

4th Annual International Concentrated Solar Thermal Power Summit
15–17 November 2010
Hotel Barcelo Renacimiento, Seville, Spain
Tel: +44 207 3757 555
E-mail: belen@csptoday.com
URL: http://www.csptoday.com/csp/

Renewable energy at a glance in India



S.No.	Source/system	Estimated potential	Achievement as on 31 March 2010
I	**Power from renewables**		
A	**Grid-interactive renewable power**	(MW)	(MW)
1	Wind power	45 195	11807.00
2	Bio power (agro residues and plantations)	16 881	861.00
3	Bagasse cogeneration	5 000	1338.30
4	Small hydro power (up to 25 MW)	15 000	2735.42
5	Energy recovery from waste (MW)	2 700	65.00
6	Solar photovoltaic power	—	10.28
	Sub total (A)	**84 776**	**16817.00**
B	**Captive/combined heat and power/distributed renewable power**		(MW)
7	Biomass/cogeneration (non-bagasse)	—	232.17
8	Biomass gasifier	—	122.14
9	Energy recovery from waste	—	46.72
10	Aero generator/hybrid systems		0.99
	Sub total (B)	**—**	**402.02**
	Total (A+B)	**—**	**17219.02**
II	**Remote village electrification**	—	5554 villages/hamlets
III	**Decentralized energy systems**		
11	Family-type biogas plants	120 lakh	41.85 lakh
12	Solar photovoltaic systems	50 MW/km^2	120 MWp
	i. Solar street lighting system	—	88 297 nos
	ii. Home lighting system	—	550 743 nos
	iii. Solar lantern	—	792 285 nos
	iv. Solar power plants	—	2.39 MW$_p$
	v. Solar photovoltaic pumps		7247 nos
13	Solar thermal systems		
	i. Solar water heating systems	140 million m^2 collector area	3.25 million m^2 collector area
	ii. Solar cookers		6.72 lakh
14	Wind pumps		1347 nos
IV	**Awareness programmes**		
15	Energy parks	—	511 nos
16	Aditya Solar Shops	—	302 nos
17	Renewable energy clubs	—	521 nos
18	District Advisory Committees	—	560 nos

MW – megawatt; kW – kilowatt; MW$_p$ – megawatt peak; m^2 – square metre; km^2 – kilometre square